

INVENTION AND DISCOVERY

COLLECTION

OF

INTERESTING ANECDOTES.

BY

RALPH AND CHANDOS TEMPLE.

Illustrated

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• INVENTION AND DISCOVERY.

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THE TRUE MOTHER OF INVENTION.

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MORE than twelve hundred patents have been granted since the beginning of the present century for new machines and improvements in machinery used in the cotton manufactures alone. When we glance at the list and find it teeming with well-known Lancashire names, we perceive at once that here as in all other branches of industry, necessity was the mother of all this world of invention—the necessity of the manufacturer, who daily and hourly felt the want of the improvements there enumerated. It has been, in fact, in the fruitful soil of our great cotton manufactures that all these devices for saving human labour and conferring abundance upon mankind, have sprung up. But for the extensive cotton manufacture, very early established in Lancashire, it may safely be assumed that the idea of the spinning jenny could not have occurred to Hargreaves; nor that of the spinning frame to Paul or Arkwright; nor that of the mule to Crompton; nor would the numerous inventions that have arisen

from these in all probability have existed, or, if at all, not in their present form. The causes which led to the establishment of this kind of industry in Lancashire were the true parent of these inventions. It is interesting, therefore, to find that all this prosperity seems to have sprung from the remarkable liberality of the Lancashire people at a period when jealousy, distrust, and seclusion were the ruling motives of nearly every branch of trade, international and domestic. More than two centuries ago the Warden and Fellows of Manchester College, in order to encourage ingenious strangers to settle in their town, granted them the benefit of the adjacent woods to cut timber for constructing their looms, at the annual charge of only fourpence each; and in this they were no doubt carrying out only a traditional policy; for the Manchester spinners and weavers were already famous. Dr. Ure remarks that these "Marts of Industry" were completely the offspring of Nature; but it is certain that they are due to these moral causes in a far greater degree than to any peculiar natural advantages; for not even the coal and iron of these districts can explain their prosperity, which had reached a considerable degree of development before steam power, or even machines, were in use.

ARKWRIGHT'S WIFE DESTROYING THE MODELS.



It is well known that Sir Richard Arkwright—to whose ingenuity and perseverance, more than to any other cause, we are indebted for the marvellous growth of our cotton manufactures—began life as a poor barber. It is now more than a hundred years since he occupied a kind of underground kitchen in the town of Bolton, in Lancashire, to which he endeavoured to attract customers by exhibiting a board with the facetious inscription, “Come to the Subterranean Barber, he shaves for a Penny.” Whether the barbers of the town really dreaded this announcement, or merely felt the customary jealousy towards an interloper—for Arkwright was a native not of Bolton, but of Preston—does not appear; but a fierce opposition is said to have been at once commenced between them. The Bolton barbers reduced their prices; but the man whose inventive genius was destined to create a revolution in British industry was not likely to be beaten when fairly roused. Arkwright took down his board, and painted out the offensive inscription; but it was only to substitute the still more alarming words—“Richard Arkwright, Subterranean Barber; a Clean Shave for a Halfpenny!” We may assume that the Bolton barbers after this left their underground rival to shave the town in peace.

Where Arkwright’s cellar was, is not exactly known—indeed, the facts relative to his early life are somewhat obscure; but Mr. French, in his *Biography of*

Crompton, informs us that a gentleman in Bolton still preserves, as a relic of Arkwright, the leaden vessel in which his customers were accustomed to wash after being shaved. Like most handicraftsmen, whose business leaves them much spare time, barbers are frequently ingenious men—a truth which appears to be as old as the Arabian Nights' Tales; most readers of which will remember the barber who left his half-shaven customers to take astronomical observations in an adjoining garden. Arkwright appears to have corresponded in many ways with that ancient prototype of Oriental humour. His mind was always filled with schemes of ingenious mechanism for shortening labour, and appears, like many other uneducated men, to have long dreamed of discovering that philosopher's stone of mechanics—perpetual motion. Like the wife of the potter, Bernard Palissy, Mrs. Arkwright was not unnaturally impatient of his neglect of the customers, who now began, we may suppose, to be more numerous in the barber's kitchen. Convinced that he would starve his family by scheming when he ought to be shaving, Mrs. Arkwright one day, in a fit of anger, destroyed some of his cherished models of machinery; and in a moment the unfortunate barber saw the fruit of his labour and ingenuity, and all the prospective wealth that they were to bring him, gone, as he thought, for ever. Arkwright never forgave this act. He separated from her immediately, nor would anything induce him ever to live with her again.

HOW ARKWRIGHT CONSTRUCTED HIS
FIRST MACHINE.

WHEN Arkwright gave up his subterranean kitchen, and withdrew from competition with the barbers of Bolton, it was only to practise a more profitable branch of their trade. Being in possession of a secret of a chemical process for dyeing human hair, whether of his own discovery is not known, he became an itinerant dealer in that article, which, owing to the universal use of wigs in 1760, was in great demand. The dyeing of hair is still accounted one of the most delicate and difficult of chemical operations, and Arkwright's secret was therefore one from which he no doubt expected great profits. According to Mr. Richardson, a hairdresser in the town of Leigh, and one of Arkwright's customers, his hair was in great esteem, and was considered the best in the country. The wandering barber guarded his secret with a jealousy which afterwards became in him a confirmed habit, and in later years was a prominent feature in his character. Yet Arkwright remained a poor man. In his solitary wanderings from village to village, collecting hair from those who were willing to be shorn, for the benefit of richer wearers of wigs, his mind was still intent upon his favourite idea of constructing new machines. The country through which he travelled was the seat of the cotton manufacture, and the inhabitants of every farmhouse, and the people of every village, were weavers or spinners with the old handwheel. Up to this time the machines used in the manufacture were of

the rudest kind, differing little indeed from those which had been employed in India from the earliest periods. The calico was generally woven by cottagers, who received from the masters a supply of linear yarn for the warp or long threads, and of raw cotton to be carded and spun for the "weft," these operations being generally allotted to the females of the weaver's family. But while the spinning had to be performed by no better machine than the old single thread-wheel, the incessant industry of the weaver's wife and children could not supply weft fast enough to keep pace with his loom, so that he was compelled to employ additional hands. Thus the complete dependence of the weaver on the spinners compelled him to pay them constantly increasing prices, and to submit without complaint to their caprices. It was a common thing for a weaver to walk three or four miles in a morning, and to call on five or six spinners before he could collect material enough for the remainder of his day's work; and when he wanted to complete an order in a shorter time than usual, the promise of a new ribbon or a new gown is said to have been necessary to quicken the exertions of the cottagers.

Arkwright, travelling through these districts, then a country of pure streams and skies unsullied by the smoke of a single factory chimney, saw and meditated on this state of things. Like the collectors of "weft" he too was an itinerant purchaser of material for a branch of industry, and the houses he visited were those in which the spinning went on incessantly, and where the weaver continually called. His old broken models were, of course, not forgotten; his dreams of a machine to embody perpetual motion, were doubtless fading out;

but what if he could devise machines for supplying
 weft, or even the stronger threads, called warp, so fast
 that all the fingers in England could not keep pace
 with their powers? Some attempts had been made
 by Lewis Paul and other ingenious men, but they had met
 with violent opposition from the spinners. Arkwright,
 however, was not daunted; he had a notion that spinning
 might be done by means of two rollers, one of which re-
 volving much faster than the other, would draw the
 twisted threads exactly as had been done by hand
 labour; a notion similar to that of Lewis Paul, but
 which he is said to have derived from watching the
 rollers employed to press out bars of red-hot iron. The
 conception grew in his mind. One day he went secretly
 to Warrington, many miles from the town in which he
 resided, and employed a watchmaker, named Kay, to
 bend some wires and turn some pieces of brass for this
 purpose. Kay was then so far trusted as to be employed
 to make a small model under Arkwright's directions,
 and the latter then applied to a machinist in the town
 to make a working machine on the plan, a task for
 which the watchmaker was incompetent. The machinist,
 however, deterred by the poverty of Arkwright's appear-
 ance, and the doubtful character of the enterprise,
 hesitated to undertake it; but in the evening of the
 day on which he was applied to, he agreed to lend the
 watchmaker the assistance of a smith and toolmaker
 to make the heavier parts of the machine, while the
 watchmaker made the lighter portions under this man's
 direction. Thus, without funds, and without encourage-
 ment, the poor barber contrived to have constructed his
 first machine, the gigantic results of which even his

sanguine temperament could hardly have foreseen. This interesting relic has fortunately been preserved, and has been recently added to the collection in the Patent Museum at South Kensington.

CUVIER AND THE FOSSIL-FOOT.

WHILE the great naturalist Cuvier was astonishing the world by his great discoveries in geology and comparative anatomy, neither the grandeur of his subjects, nor the novelty of the truths which he brought to light, led his severely philosophic mind into rash hypotheses. The chalk quarries of Montmartre, in the neighbourhood of Paris, afforded him a continual supply of specimens of fossils, and every load of fragments brought from thence to his house by the Garden of Plants was studied with intense delight. At these quarries he employed, at his own expense, an intelligent workman to collect the bones continually found there; and all who could bring genuine specimens to his door were rewarded with as much liberality as his scanty fortune would allow. Before he had published his great discoveries, and when the expense of employing professional artists was beyond his means, he not only drew but engraved the plates himself, and many of these valuable proofs of his industry are scattered through his great work on fossil remains. Subsequently M. Laurillard became his secretary, and was associated with him in these researches. Of the origin of Cuvier's friendship for

• this gentleman we are told a characteristic story. Laurillard was a native of the same town as Cuvier, and had left his birthplace to pursue the profession of an artist, in which capacity he had executed some trifling work for the great naturalist, but without particularly attracting his notice. One day, however, Cuvier went to his brother's apartment to ask for some help in digging out a fossil from the mass of rock in which it was embedded. The young artist happened to be the only person to be found on the spot, and he cheerfully lent assistance. Little aware of the value of the specimen entrusted to his care, he succeeded in getting the bone out entire, thus succeeding almost beyond expectation in carrying out the wishes of Cuvier. In a short time the latter returned for his treasure, and when he saw how perfect it was, his ecstasies became uncontrollable; he danced, shook his hands, and uttered expressions of delight, till Laurillard, ignorant both of the importance of the discovery, and of the ardent character of Cuvier, thought he was mad. Taking the fossil-foot in one hand, and dragging Laurillard's arm with the other, Cuvier led him up-stairs to present him to his sister-in-law, saying, "I have got my foot, and M. Laurillard found it for me!" He had, indeed, long been meditating on the existence and form of a foot which he had vainly sought; so that when he appeared particularly absent, his family were wont to accuse him of seeking his fore foot. The next morning Laurillard was engaged as Cuvier's secretary, and proved an able coadjutor and faithful friend, destined to be remembered with his illustrious master as long as mankind shall be grateful towards the great discoverers in science.

STEPHENSON AND THE LAWYER.

AMONG the most interesting episodes in the career of George Stephenson are the contests which he was compelled to maintain with clever lawyers, who were employed to cross-examine him before committees of the House of Commons on the merits of the particular railways which he was engaged to construct. The late Baron Alderson, then a rising practitioner at the bar, was one of these tormentors of the untaught man of science. Mr. Alderson had a morbid dislike of change, and he is said to have conducted the cross-examination in the tone of a man hurt in his feelings by the idea of a steam train going through space at the rate of twelve miles an hour. The following is a good specimen of one of these scenes:—"Of course, (the question was put with reference to the proposed speed) 'when a body is moving upon a road, the greater the velocity the greater the momentum that is generated?'—'Certainly.'—'What would be the momentum of forty tons moving at the rate of twelve miles an hour?'—'It would be very great.'—'Have you seen a railroad that would stand that?'—'Yes.'—'Where?'—'Any railroad that would bear going four miles an hour; I mean to say that if it would bear the weight at four miles an hour, it would bear it at twelve.'—'Taking it at four miles an hour, do you mean to say that it would not require a stronger railway to carry the same weight twelve miles an hour?'—'I will give an answer to that. Every one, I dare say, has been over ice, when skating, or seen persons go over; and

they know that it would bear them at a greater velocity than it would if they went slower; when it goes quick, the weight in a manner ceases.* — 'Is not that,' asked the lawyer, with a triumphant glance at his audience, 'upon the hypothesis that the railroad is perfect?' But the witness was not to be taken aback. With an equally triumphant glance he replied immediately, 'Yes, and I mean to make it perfect.'"

The lawyer now started upon another tack:—"Do not wrought-iron rails bend?" he asked; "take Hetton Colliery, for instance?"—"They are wrought iron, but they are weak rails."—"Do you not know that they bend?"—"Perhaps they may, not being made sufficiently strong."—"And if made sufficiently strong, that will involve an additional expense?"—"It will."—"You say the machine can go at the rate of twelve miles an hour. Suppose there is a turn upon the road, what will become of the machine?"—"It would go round the turn."—"Would it not go straight forward?"—"No."—"What is to be the height of the flanch of the wheel?"—"One inch and a quarter."—"Then if the rail bends to the extent of an inch and a quarter, it will go off the rail."—"It cannot bend. I know it is so in practice."—"Did you ever see forty tons going at the rate of twelve miles an hour?"—"No; but I have seen the engine running from eight to ten miles round a curve."—

* There is, probably some error in the report. In fact, the very reverse of this proposition is the truth. The principle now acted on through our railways, is, we believe, to slacken the speed of trains upon approaching bridges of any considerable length; and the same rule of going slowly is, we believe, always observed in passing over an unsound part of an embankment.

'What was the weight moved?'—'I think little, except the engine.'—'Do you mean to tell us that no difference is to be made between those forty tons after the engine, and the engine itself?'—'It is scarcely worth notice.'—'Then, though the engine might run round and follow the turn, do you mean to say that the weight after it would not pass off?'—'I have stated that I never saw such a weight move at that velocity; but I could see at Kilingworth that the weight was following the engines, and it is a very sharp curve: it is a sharper curve there than I should ever recommend to be put on any railroad.'—'Have you known a stage-coach overturn when making not a very sharp curve, when going very fast.'—'Often enough,' replied the engineer, with a sly smile; 'but stage-coaches with a dozen passengers outside are top-heavy, and trains are not. You see that makes all the difference.'"

SAMUEL CROMPTON AND THE "SPIES."

ONE of the first inconveniences that Crompton experienced from the success of his "spinning mule," arose from the curiosity of the public concerning it. Numbers came eager to obtain a sight of it. When denied the house, they climbed up ladders to the windows, one even concealing himself for several days in the cockloft where he watched Crompton at work through a gilet-hole pierced in the flooring. Arkwright himself was one of these visitors. Feeling the impossibility of preserving

a secret which every one could carry away with his eyes, Crompton at length resolved to throw it open to the public, though not unconditionally. Some friends and others were permitted to see it, among whom was Robert Peel, the father of the eminent statesman, who brought with him two mechanics to examine its construction. Crompton obtained a written promise of a subscription of a guinea each from a number of persons to recompense him for divulging his secret; but when the time came for calling in the subscriptions, many who had put down their names refused to pay, and when everything was gathered in and deductions made, Crompton found himself possessed of less than sixty pounds, just as much money as built him a new machine with only four spindles more than the one he had given up. Crompton felt the injustice done him so keenly, that one day he seized his axe and broke his carding machine to pieces, exclaiming, "They shall not have this too!"

THE WAR OF THE "KNOBS AND POINTS."

A SINGULAR kind of scientific feud arose in the reign of George III., out of Franklin's discovery of the power of rods and points in conducting and drawing off electricity. Franklin had modestly inquired whether the knowledge of this power might not be of use to mankind in preserving houses, churches, or ships from lightning, by directing us to fix on the highest parts of those edifices

upright rods of iron made as sharp as a needle, and thus "drawing the electrical fire silently out of a cloud before it came nigh enough to strike, and thereby secure us from that most sudden and terrible mischief." Experiments proved to Franklin's satisfaction the truth and great importance of this suggestion; but the Abbé Nollet, a great authority in France on Natural Philosophy, solemnly warned the Academy of Sciences in a memoir read before them against "those iron points which people are erecting in the air," and which, he asserted, were more calculated to bring destruction upon a building than to ward it off! In England, however, the great philosopher's discovery was received with more favour. The Dean and Chapter of St. Paul's, alarmed by the fact of St. Bride's Church, Fleet Street, having been struck by lightning and seriously injured, applied to the Royal Society for advice against a similar accident to the cathedral; and they were recommended to "make a complete metallic communication between the cross placed over the lantern and the leaden covering of the great dome." This was done about 1769, and the water pipes already existing were made to serve as conductors from the roof to the ground. A year or two later, the Royal Society were called on by the Government to advise for the protection from lightning of the powder magazines at Purfleet, and a committee of the society strongly recommended the use of *pointed* conductors.

Then, for the first time, arose a controversy which afterwards assumed historical importance. One member of the committee, named Wilson, protested that he was in favour of knobs instead of points to the cor-

ductors, being apparently under the impression that points invite the stroke. Points were ultimately adopted, but unfortunately some countenance was given to the knob theory, by the circumstance that the magazines were struck by lightning in 1777, and slightly injured, though the powder was not exploded, while a house at Tenterden similarly furnished was also struck. The opponent of points now claimed a triumph; but a committee of the Royal Society, composed of the most eminent men of science of the time, made experiments and again reported in favour of points. Wilson was greatly incensed at this new decision against his favourite notion. Parties were formed on either side, and the fact that Franklin was one of the most conspicuous of the "rebels," then waging war with the king's troops in our American colonies, quickly gave to a purely scientific question a political significance. The advocates of blunt points soon became identified with the insurgent colonies, while the opponents of "knobs" were considered disaffected subjects. The populace, and even the higher classes of society took up the quarrel, without knowing anything of its scientific merits; and to put up rods without knobs was a sure way to lead to a breach of the peace. Meanwhile the king, in defiance of the judgment of the men of science, ordered all point-conductors to be removed and knobs to be substituted. The good Franklin wrote with a lash of bitterness, which may be pardoned to the feelings of the illustrious "rebel." "I have never entered into any controversy in defence of my philosophical opinions; I leave them to take their chance in the world. If they are right, truth and experience will support them; if wrong, they ought to be

refuted and rejected. Disputes are apt to sour one's temper and disturb one's quiet. I have no private interest in the reception of my inventions by the world, having never made, nor proposed to make, the least profit by any of them. The king's changing his pointed conductors for blunt ones is, therefore, a matter of small importance to me. If I had a wish about it, it would be that he had rejected them altogether as ineffectual. For it is only since he thought himself and family safe from the thunder of heaven that he dared to use his own thunder in destroying his innocent subjects." The king, it is said, actually endeavoured to make the Royal Society rescind their resolutions in favour of the hateful points, and had an interview with Sir John Pringle, the then president, during which he earnestly entreated him to use his influence in supporting Mr. Wilson. The reply of the president was dignified and worthy of his position. "My duty, sire," he said, "as well as my inclination, would always induce me to execute your Majesty's wishes to the utmost of my power, but I cannot reverse the laws and operations of nature." The king, less easily satisfied than King Canute with this kind of answer, is said to have replied petulantly, "Perhaps, Sir John, you had better resign." It was in allusion to this affair that a friend of Franklin's penned the following highly treasonable epigram:—

"POINTS OR KNOBS."

While you, great George, for knowledge hunt,
And sharp conductors change for blunt,
The nation's out of joint;
Franklin a wiser course pursues;
And all your thunder useless views
By keeping to the point.

THE STORY OF "WEDGWOOD-WARE."

JOSIAH Wedgwood, whose name must always be associated with the history of pottery and porcelain, was born at Burslem, in Staffordshire, in 1730, and was the son of a very poor man who laboured at that place as a potter, or maker of the rude kind of earthenware then in use. Even the better classes at that time ate their meals off pewter or brass plates, while foreign china, and indeed all but the rudest pottery, was regarded rather as an ornament for sideboards or mantelpieces than as a thing of real utility. Zimeon Shaw, the historian of Staffordshire, says that scarcely any person in Burslem learned more than mere reading and writing till about 1750, when some individuals endowed the free school for instructing youth to read the Bible, write a fair hand, and know the primary rules of arithmetic. Shaw tells us also that at eleven years of age, his father being then dead, Wedgwood was working as a thrower in his elder brother's pottery. Shortly after this, the small-pox—that terrible scourge which, as yet, no Jenner had arisen to subdue—attacked the lad, and after a long and miserable illness left him with a lameness in his left leg which, afterwards rendering amputation necessary, compelled him to quit the monotonous drudgery of the potter's wheel.

When a young man he left Burslem for awhile, and entered into a sort of partnership with another working potter, named Harrison, at Stoke, in the neighbourhood. The partnership lasted but a short time; for the young

potter from Burslem spent more time in designing improvements in the shapes and patterns of the articles they manufactured, than was likely to be approved of by a partner of a less speculative turn of mind. It was here that Wedgwood's talent, or rather his passion for producing ornamental pottery, began to develop itself. He returned to his native place and entered into a new partnership with a potter named Wheildon, devoting himself to the designing and manufacturing of knife-handles, in imitation of agate and tortoiseshell, melon table-plates, green pickle leaves, and similar kinds of porcelain ware. His new partner, however, was not more indulgent than the Stoke potter towards new-fangled manufactures, which diverted his attention from the ordinary departments of the pottery business, in which he found a sufficiently profitable field for his industry. It is evident that, although he was a practical potter, Wedgwood's partners looked upon him as a dreamer, and were suspicious of his predilections for devising and inventing. The second partnership ended like the first, and at the age of twenty-nine Wedgwood again repaired to Burslem; but this time not to be curbed by the will of any partner, but to show those who had refused to support him in his day dreams how much they had lost by their short-sightedness.

In a small thatched house at Burslem, happy in being his own master at last, the Stoke potter devoted himself alone to the accomplishment of his long-cherished dream of creating a demand for something higher, by improving the productions of his art. Here he began to prosper; took a second manufactory, in which he fabricated a white stoneware, and subsequently established

himself in a third, where he produced that cream-coloured ware by which he gained so much celebrity. Of this new kind of pottery Wedgwood was permitted to present some specimens to Queen Charlotte, who therefore ordered a complete table-service—the first royal table-service of English manufacture which had been used—and was so pleased with its execution as to appoint him her potter, and to desire that his manufacture might henceforth be designated “The Queen’s ware.” Wedgwood had observed that a certain earth which contained silica, and which was originally black, became white after burning it in a furnace. Meditation on this fact led him to the notion of mixing silica with the red powder of the potteries, and to the discovery that the mixture became white when calcined. Only one step more remained. By coating this material with a transparent vitrification, commonly known as the glazing, he produced that English earthenware which has become so widely used, and which now figures so largely in the list of our exportations. Suddenly six different kinds of stoneware, hitherto supposed to be unproducible in this country, made their appearance from his manufactory in Staffordshire, delighting and astonishing the connoisseurs, and causing no small consternation among the possessors of valuable old china, who saw a prospect of their treasures being diminished in value by the unexpected discovery that an Englishman could rival the best productions of foreign art.

THE RAILWAY IN ITS CRADLE.

NEARLY ninety years ago an enthusiastic mechanic, named Oliver Evans, was notorious in the city of Philadelphia in the United States, as the advocate of a wild scheme for using steam as a locomotive power. Like most earnest men, Evans was considered by his acquaintances as somewhat of a "bore," and his notions of "expansive force," and of turning a destructive enemy into a "useful servant," were generally met with derision. But Evans only held on the closer to his favourite notion. In 1787 he actually obtained from the state of Maryland an exclusive right to make and use steam waggons, and he offered to make a steam carriage that "would run on a level road with the swiftest horse," and at another time to furnish steam carriages that would "run at the rate of fifteen miles an hour on good level railways." His countrymen, however, took no heed of him. He was undoubtedly somewhat of a visionary; but however defective in details his contrivances may have been, time has shown that the objects he undertook to accomplish were attainable. The unfortunate Oliver Evans, however, cried in vain to be heard. He died neglected, and was forgotten.

It was seventeen years later that the exhibition on the Merthyr Tydvil Railway took place; but no less than ten years elapsed before any considerable advance can be said to have been made in the application of steam to locomotion on land. The great obstacle was the supposed want of hold or adhesion of the wheels

upon the rails. No want of adhesion had been actually experienced by any one, but people generally assumed that such would be the case, and that was all. Had but a single experiment been made to ascertain whether "want of hold or adhesion" was really the sort of obstacle which it was supposed to be, ten or fifteen years of inventing and contriving to overcome that obstacle would have been saved, and the talent and ingenuity thrown away on the visionary pursuit might, when applied—as it would have been—to a removal of the real difficulties, have gained just so many years' march on the road of improvement.

The world may be said to have slept in the belief that locomotive engines could not drag trains along lines of rail until 1812. In that year the "viewer" of the Wylam Colliery, near Newcastle-upon-Tyne, was an ingenious man, named William Hedley. It was the year of Napoleon's retreat from Russia, when his gigantic army perished in the snows—a terrible year of cold and distress, when wheat in England reached its highest point it had attained for these hundred years, and famine stared the people in the face. The trouble which, however, day and night haunted the mind of William Hedley, was the high price of fodder for cattle. All the coals from the Wylam Colliery were carried by a long tramway in trucks dragged by horses to the place of shipping; and Hedley knew well that unless something could be invented to supersede horses in the conveyance of the coals, it would be impossible to continue to work the tramway. He saw nothing before him but the prospect of the closing of the colliery, and of himself and his wife and family being cast on the

world. In a state of despondency he retired to bed one night in the autumn of the year 1812; but it was not to find repose. Suddenly the idea flashed across his mind that if all the wheels of a moving carriage were connected, a tendency in any particular set of wheels to surge or revolve on their axes without moving forward, might possibly be overcome by the remaining wheels. He determined to ascertain if this was the fact. On the following morning he ordered a frame and wheels to be made, and with the help of a clockmaker in Newcastle, completed his model. It was successful, and he had the satisfaction of seeing his notions realized within twenty-four hours; and eventually he had the happiness of inventing and building the first locomotive engine moving by the friction of the wheels upon the road. It was extremely slow in its movements, but it served his purpose, and above all consumed neither hay nor oats, wanted nothing, in short, but that coal in which the neighbourhood abounds.

The original Wylam locomotive is now in the Patent Museum at South Kensington. A rude, old weather-beaten, rusty machine of gigantic size and ponderous appearance, it was nevertheless in constant use at the colliery from 1813, when it was constructed, until June, 1862, when it was removed to the honourable asylum in which it now finally rests from its labour. At Wylam it was called by the country people "Puffing Billy," from the great noise it made, and it never received any other name. The career of "Puffing Billy" had almost been brought to a premature close, while its owner narrowly escaped a lawsuit in his defence. His perpetual puffing and snorting along the road was voted a

nuisance; landlords complained, and great lawyers were appealed to on legal cases solemnly drawn up. But "Puffing Billy" was too good a friend to Newcastle folks to be allowed to be put down. The colliery went on, William Hedley retained his employment, remained at Wylam for many years, and died in 1842.

THE FIRST HOT-PRESSER OF PAPER.

THE practice of hot-pressing, by which so beautiful a gloss and flatness is given to printed paper—particularly that used for expensive books—was the invention of Mr. Thomas Turnbull, the founder of the well-known firm of cardboard makers of that name.

Lighty years ago, as all persons know who have looked over old letters of that period, writing papers were made with an extremely rough surface, on which it now seems difficult to understand how pens could have been made to mark. Even the system of "rolling" was then unknown; and printing paper was invariably disfigured by a coarse surface, while the impression of the type, where the paper was not thick, was generally to be seen through the reverse side. Our forefathers probably thought such matters unworthy of serious attention; although now every stationer and book seller knows that the public have since learned to regard them as important. No one, at all events, had hitherto

thought of remedying them; and the improvement finally came from the ingenious idea of a man in no way connected with paper-making or publishing. Thomas Turnbull was a young workman in the employment of Mr. Sparrow, a packer and 'hot-presser' of cloths, which were the only articles then 'hot-pressed.' Mr. Sparrow having died, a number of circulars announcing the fact to his customers were ordered by his widow to be printed. The circulars, when they came from the printer's, damp and uneven, with printmarks on the back, were disagreeable to the eye of the young workman; he had a leisure half-hour, and it struck him to put each between glazed boards and subject the printed paper to the same pressure from hot iron plates screwed down by powerful machinery, which he had been accustomed to give to cloth and silk. The result showed an improvement so striking that he was at once convinced that the new application of the process, trifling as it seemed, was important. Having an enterprising mind, he soon afterwards took a small shop in Booth Street, Spitalfields, set up presses, and went himself to stationers and publishers with specimens of his work. The system spread, although, as in the case of other luxuries, it was at first ridiculed as an absurd piece of foppery. Mathias, in his satirical poem, entitled, "The Pursuits of Literature," published in 1794, frequently denounced the new absurdity. "All books," he says, "are now advertised to be printed on wire-wove paper, and *hot-pressed*, down to the 'Philosophical Transactions' and Major Rennell's learned 'Memoir on Hindostan,' as if the intention were that they should be looked at and not read." Thomas Turnbull extended the hot-pressing.

system to cardboard making, in which art he gained a great reputation, which is still enjoyed by his descendants.

BRUNEL'S PROPHECY.

THE elder Brunel, who was a Frenchman, and born in Normandy, had from his earliest years a desire to visit the country which he afterwards adopted as his own, and in which he subsequently made his reputation. When a boy, he frequently went to Rouen, that great mercantile city to which, in spite of the foolish restrictions which so long encumbered the French mercantile laws, some productions of British skill and industry have always found their way. Here his attention was constantly excited by two large cast-iron cylinders which had been landed and were allowed to remain upon the quay. Compared with his own height they seemed to him gigantic, and he was curious to know their history, what was their use, and whence they came. At last a man aboard a ship alongside the quay beckoned to him to come down the ladder, and offered to tell him what he had heard the boy asking for. The kindly sailor man told the boy that the cylinders were part of a "fire" engine—for so steam engines were called in the early days of their history; that they were just arrived from England, where the people were constantly making such things, and chiefly to be used in raising water where human strength, or even horse power, would be

ridiculously insufficient for the purpose. The boy listened eagerly, and then, according to Mr. Beamish, exclaimed, "Oh, when I am older, how I shall like to go and see that country!" The Quay at Rouen, after this, became a favourite loitering-place for him; and on another occasion seeing here the different parts of a carriage recently landed, he said, "How clever the folks are in that country! I shall go to see it when I am older." Brunel remembered these words long afterwards as something almost prophetic of the future career of the engineer of the Thames Tunnel, which so many foreigners now visit as one of the most remarkable sights in this engineering country.

The Reign of Terror in 1793 drove Brunel from France. He was then twenty-four years of age. In his sixty-ninth year, during a suspension of the works of the Thames Tunnel, he paid a visit to his native town of Hâcqueville. He records this visit pathetically in his diary, in his original language, "I met no one whom I knew," he says, "but Penchon the joiner. Penchon must be seventy-two years of age now. I spoke to him as he was looking from his window. He did not know me. I entered by the window, to his great astonishment, and told him who I was. He showed me a part of the first frame of an instrument which I had attempted, and afterwards succeeded in making; then some wheel-work, and other things. He called his wife, a beautiful woman fifty years ago, now aged like himself. She regarded me with a bewildered look for some time without speaking, and then exclaimed, "Ah! it is Monsieur Isambard; but, oh, how he is changed!"

THE BOY AND THE STEAM ENGINE.

THE story of Humphrey Potter, the Cornish boy, who invented the self-acting valve for Newcomen's rude steam engine, is strikingly told by M. Arago the great astronomer. Newcomen's first engine required the most uninterrupted attention from the person who had to open and shut the taps, either to introduce the steam into the cylinder or to throw in the cold shower intended to condense it. It happened on a certain day that this person was young Potter. The companions of this child were then at play, and their exclamations of joy tantalized him severely. He longed to go and join them; but the task entrusted to him would not allow of half a minute's absence. His mind became excited; strong passion awoke his genius, and he discovered relative connections of which he had never dreamt before. Of the two taps, the one was to be opened at the moment when the beam that Newcomen had been the first to introduce to such good purpose in his engines had completed the descending oscillation, and it must be shut exactly at the opposite oscillation. The management of the second tap required to be the exact contrary. The positions of the balance and of the taps were necessarily dependent on each other. The boy's quick invention seized on this fact. He perceived that the beam might impress on the other pieces all the motion that the play of the engine required, and instantly realized his conception. Several cords were quickly fastened to the handles of the taps; the opposite ends Humphrey Potter

tied to portions of the beam suitably selected. Thus the purchase which this exercised on certain cords while rising, and those that it exercised on others in descending, supplanted the manual efforts. For the first time the engine worked by itself; for the first time no other workman was near it but the stoker, who from time to time went to keep up the fire under the boiler. For the cords which the boy used the constructors soon substituted rods fixed to the beam, and furnished with several pegs, which pressed the heads of the taps on valves either downwards or upwards. The rods themselves have long ago been exchanged for other combinations; but in the words of M. Arago, however humiliating such an acknowledgment may be, all these inventions are mere modifications of the mechanism suggested to a child by the wish to join his little companions at play.

DR. BUCKLAND WATCHING THE BUILDERS.

Among other anecdotes told of the late Dr. Buckland, to whom we are indebted for many geological discoveries, we are told that he looked very sharply after the masons when repairing Westminster Abbey, or any other of the collegiate buildings in which he had any interest, examining the various kinds of cements, the blocks of building-stone, the means adopted to repair and keep in order the regal and other monuments; and taking special care that no faulty bits of stone, etc., were used.

Many years ago, when the turrets of a certain tower of Christ Church, Oxford, were undergoing repairs during the long vacation, he had reason to suspect that all was not right. It was almost impossible for him to ascend by the slender scaffolding to these turrets; so, from the window of his house (he was then Canon of Christ Church) he bethought him of watching the masons through the telescope (a very good one) with which he used to examine distant geological sections. At last the unsuspecting mason, working, as he thought, far above the ken of man, put in a faulty bit of stone; the learned doctor, on the look-out below, detected him through the telescope, and almost frightened the man out of his wits, when, coming out into the quadrangle, he admonished him to bring down directly "that bad bit of stone he had just built into the turret."

AN IMPROMPTU INVENTION.

A REMARKABLE illustration of the truth that ingenious men, probably from the habit of grappling with difficulties, frequently overlook simple and obvious means of attaining their objects, is afforded by an anecdote related of the origin of Arkwright's partnership with Mr. Strutt, the well-known patentee of the stocking frame, who was the first to appreciate the machine for spinning by rollers. A serious defect in that machine, and one which had cost its inventor much annoyance,

was the tendency of the rollers to catch and hold the fibres of cotton. The defect having been noted by Mr. Strutt, Arkwright confessed that he had found it irremediable. "I think I can cure it," remarked the former, "but it must be on condition of sharing the profits." So beneficial an offer was immediately acceded to; the terms were agreed on, and Arkwright and his new partner entered the mill. Here Mr. Strutt simply took a piece of chalk from his pocket and rubbed the roller thoroughly, bidding his companion try the effect. The success was complete—the clinging of the cotton fibres was instantly at an end. Simple as was the remedy, it had attained its object, and fairly earned for its shrewd inventor the reward for which he had stipulated.

THE FIRST PHOTOGRAPHERS

It has long been known that at the beginning of the present century Josiah Wedgwood, the famous potter, Sir Humphrey Davy, and James Watt, made experiments upon the action of light upon nitrate of silver, but it is only lately that evidence has been found of the fact of their having succeeded in any degree in permanently fixing the image thus obtained. Some person searching for other purposes in an old lumber room which belonged to Watt's partner, Matthew Boulton, discovered a silvered copper plate, having on it a representation of the old premises at Soho, which appeared to have been evidently taken by a photographic process. This plate is now included in

the collection at the Museum at Kensington. In the account published of it, it is stated that an old man of ninety, recently dead, or still alive, remembers that Watt and others used to take portraits of people in "a dark room"—the latter fact, probably, nothing but that they were taken secretly; for there is a letter extant of Sir William Beechey, begging the philosophical body at Birmingham, calling themselves the "Lunar Society," to desist from these experiments, as were the process to succeed would ruin portrait painting.

WILLIAM FLAKEFIELD'S LINEN HANDKERCHIEF.

THE writer of a recent work recommends to the people of Glasgow the erection of a statue to a now almost forgotten hero, William Flakefeld, and that great manufacturing city can certainly have had few benefactors more worthy of that honour. The story of William Flakefeld, whose true name was Wilson, is somewhat romantic.

Wilson and his father and brother, poor Scottish weavers, settled in Glasgow in the time of William III. The townspeople, to distinguish William from his brother, commonly called him Flakefeld, which was the name of the place in which he was born, of East Kilbride in which he had lived, and finally, the name. Being a fine young fellow he joined the Highlanders, and accompanied the army to the New Country, where the war was then raging. Here he was struck one day

which he had bought, of a simple pattern woven in blue and white. Simple as it was, the eye of the weaver detected beauty in it, and it was at least superior to the coarse productions of the looms of his native country—at least of those which produced cheap goods for the humbler classes. Flakefield never parted with his handkerchief, but kept it carefully, determining, if he was able, to weave one like it when the opportunity should offer. He came back to Scotland in 1697, when the peace was concluded with France, and settling down again, hung up his sword and belt in his weaver's garret, and once more pursued his labours with the peaceful shuttle. He had still in his possession the white and blue pocket-handkerchief, the companion of his wanderings; and after many obstacles, scarcely to be imagined in these days of improved machinery and appliances, succeeded in making one exactly like it. In a short time he had a dozen ready for sale; the first, it is said, of the kind woven in Great Britain. The pattern was liked by the Scottish people, and was soon seen both among the poor townfolk and the humble peasants to whose homes the indefatigable pedlar of those times took them in their wanderings. Looms rapidly increased; and in a few years Glasgow became famous for this new branch of the linen trade. Many indeed profited by the manufacture and sale of Flakefield's handkerchiefs, except the poor weaver himself. He had but little capital; and his time was spent upon the loom, he could not of course compete with the rich employers of labour who adopted it. Flakefield, it is said, died in the humble position of the town drummer.

THE CHILDHOOD OF JAMES WATT

WATT was, from his birth, of an extremely delicate constitution, unfitted for taking part in the common sports of boys, and little prepared for those struggles with difficulties which afterwards marked his career. His mother, who was a woman no less remarkable for her intelligence than for her personal graces, taught him to read when scarcely out of his infancy, and his father, who was a ship's carpenter and dealer in naval stores at Greenock, added a little writing and arithmetic. In the latter the child rapidly improved, and he was fond of working out his sums with a pencil upon scraps of paper, or more commonly with a piece of chalk upon the floor, sometimes his only amusement when the severe headaches to which he was subject compelled his parents to keep him at home. On one occasion when he was bending over a stone hearth with the usual piece of chalk, a visitor who was present remarked to the father, 'The boy ought to be sent to a public school, and not permitted to idle away his time at home.' "Look at what my child is doing before you blame him," returned the father. The child of six years of age was endeavouring to solve a problem in geometry. Another time he was scolded by his aunt Murrison, who was taking tea with the Watts, for his want of industry. "Jimmy," said the worthy lady, "I have seen much of you, and you are an idle boy as you are. Pray take a book and employ yourself usefully, for the last hour you have been idle. Open your book, but taken off the lid of that kettle and put it on."

again, holding now a cup and now a spoon over the steam, watching how it rises from the spout, catching and counting the drops it falls into. Are you not ashamed of spending your time in that way?" The little James playing with the tea-kettle, observes M. Arago, who tells this story, became the mighty engineer preparing the discoveries which were to immortalize him.

THE YOUTH OF JAMES WATT.

WHEN he had left the grammar-school of his native town Watt received no more scholastic education, but then began that system of self-culture which he pursued to the end of his long life. He was, naturally, a solitary lad, and liked to ramble among the fine scenery in the neighbourhood of Greenock. The few old nautical instruments which he found among his father's stores inspired him with a curiosity on the wonders of astronomy, for he could not, throughout life, see a machine or instrument without a longing to understand its uses. By the time he was fifteen, he had twice read with great attention S'Gravesande's Elements of Natural Philosophy. While under his father's roof he went on with various chemical experiments, repeating them again and again until satisfied of their accuracy. When sixteen he made himself a small electrical machine, an instrument at that time but little understood. He also read eagerly books of medicine, and

even practised dissection; for on one occasion he was found carrying away the head of a child who had died of some unusual disease; a remarkable instance of his suppression of his own feelings in his pursuit of scientific truth, for suggestions of suffering or disease were always peculiarly painful to him. In later life he said that, "had he been able to bear the sight of the sufferings of patients he would have been a surgeon." Botany and mineralogy were among the subjects which he studied in the open air in the neighbourhood of his native town. He read every book which fell in his way, and which promised to enlighten him upon some branch of inquiry. To a friend who blamed him for reading so many different kinds of works, he replied, "I have never yet read a book, or conversed with a companion without gaining information, instruction, or amusement."

BENJAMIN HUNTSMAN AND THE PROCESS OF MAKING CAST STEEL.

THE story of how Benjamin Huntsman, the inventor of the art of making cast steel, was deprived of the secret of his art is told with great force and picturesque power in Dr. Scoffern's valuable little work entitled, "The Useful Metals and their Alloys."

One cold winter's night, says the writer referred to, while the snow was falling in heavy flakes, and Huntsman's manufactory, near Sheffield, threw its red glare of

light over the neighbourhood, a person of the most abject appearance presented himself at the entrance, praying for permission to share the warmth and shelter which it afforded. The humane workmen found the appeal irresistible, and the apparent beggar was permitted to take up his quarters in a warm corner of the building. A careful scrutiny would have discovered little real sleep in the drowsiness which seemed to overtake the stranger; for he eagerly watched every movement of the workmen while they went through the operations of the newly-discovered process. He observed, first of all, that bars of blistered steel were broken into small pieces, two or three inches in length, and placed in crucibles of fire-clay. When nearly full, a little green glass broken into small fragments was spread over the top, and the whole covered over with a closely-fitting cover. The crucibles were then placed in a furnace previously prepared for them, and after a lapse of from three to four hours, during which the crucibles were examined from time to time to see that the metal was thoroughly melted and incorporated, the workmen proceeded to lift the crucible from its place on the furnace by means of tongs, and its molten contents, blazing, sparkling, and spurting, were poured into a mould of cast iron previously prepared; here it was suffered to cool, while the crucibles were again filled, and the process repeated. When cool, the mould was unscrewed, and a bar presented itself, which only required the aid of the hammer-man to form a finished bar of cast steel. How the unauthorized spectator of these operations effected his escape without detection tradition does not say; but it tells us that, before many months had passed, the Huntsman

manufactory was not the only one where cast steel was produced.

This man is believed to have been an ironfounder, named Walker, who carried on his business at Greenside, in the neighbourhood, where it appears clear that the making of cast steel, which had cost Huntsman so many years of toil and expense, was shortly afterwards commenced. Huntsman was of German extraction, and was born in Lincolnshire in 1704. He was apprentice to a clockmaker and mender, where he learnt to repair clocks and roasting-jacks, and developed a mechanical turn. He also became an itinerant vendor of remedies for diseases. It was the difficulty which he experienced in obtaining good springs and pendulums for his clocks which first led him to turn his attention to the manufacture of a better kind of steel than was then procurable, and thus conducted him by laborious steps to those important discoveries which are identified with his name.

THE FICTION OF SALOMON DE CAUS.

A FEW years ago, the French public were startled by the announcement that evidence had been discovered that the glory of the invention of the steam engine had been erroneously assigned to England; the idea at least having been anticipated by a Frenchman long before Watt, or even Savery or Newcomen had been heard of. The form in which this story was brought forward was

that of a letter purporting to be written by the celebrated Marion de Lorme in 1641, and addressed to her lover, Cinq-Mars, informing him that in doing the honours of Paris to his English friend, the Marquis of Worcester, she had accompanied him to the famous madhouse in the environs of that city, called Bicêtre, and that here they had heard a miserable captive exclaim from behind his bars, "I am not mad! I am not mad! I have made a discovery which would enrich the country that adopted it." The letter then relates that the writer and her companion ascertained from a keeper that this was one Salomon de Caus, who had written a book of which the keeper at once produced a copy, after a perusal of which the Marquis requested an interview with the madman, and on leaving Bicêtre declared that in it was confined the greatest genius of the age. The discovery, coupled with the fact that M. Arago, in a celebrated article on the History of the Steam-engine, published in a French scientific journal, had aroused the attention of his countrymen to the respective claims as inventors of De Caus and the Marquis of Worcester, served to confirm the belief that De Caus was the originator of the idea of turning the expansive force of steam to useful purposes. The idea of a great discoverer perishing unheeded in a public madhouse struck the imagination of artists. A painting at the exhibition of the Louvre, of the miserable De Caus raving through the bars of his dungeon at the heedless woman of fashion and her shrewd companion, had a great success, was multiplied by lithography and engraving, and appeared in a London illustrated newspaper. A drama, also founded on the main incident of the anecdote, was a few years since per-

formed in London and Paris; and grave biographical dictionaries, on the faith of the alleged letter of Marion de Lormie, inform their readers that it is now proved in the most positive manner that De Caus ought to be regarded as the inventor of the steam-engine.

This singular imposture has now, however, been completely exposed. Mr. Muirhead, in his life of Watt, remarked that the tone and language of the letter betrayed throughout its modern origin; and also that in 1641 there was no Marquis of Worcester at all, that title having first been conferred on Henry Somerset, in 1642, who moreover was not the marquis who wrote the "Century of Inventions," but his father. To these facts, conclusive in themselves, a French writer, M. Figuier, adds among other things the criticism that, as Salomon de Caus died in 1630 he could hardly be found shut up in a madhouse in 1641; and that, moreover, Bicêtre was at that time not a hospital at all. It appears that this pretended letter was first published in a French periodical entitled, "The Musée des Familles," a kind of French penny magazine in 1831. Such is the authority on which this palpable fraud has for some time been invested with the dignity of history.

THE INVENTOR OF PRINTING FOR THE BLIND.

THE whole credit of the beautiful invention of printing for the blind, so simple yet so marvellous in its results, belongs to France. It was Valentine Haüy, who, in

1784, at Paris, produced the first book printed with letters in relief, and soon afterwards proved that children might easily be taught to read with their fingers. It is stated by his biographer that he took his idea of embossed typography from seeing that a blind pianist from Vienna, who visited Paris that year, distinguished the keys of her instrument by the sense of touch, and also readily comprehended the maps in relief, which a short time before had been invented by a German. After employing letters of different forms and sizes, and experimenting with the blind as to the precise shape of the letter that could be the most readily distinguished by the touch, he at length fixed upon a character differing very slightly from the ordinary Roman letter, or perhaps a little approaching italics. He submitted his first efforts and experiments to the Academy of Sciences of Paris, and their favourable report rendered his success a triumph. Great *éclat* attended the public announcement of this invention. A new institution was established, called the Royal Institution for young Blind Persons, and Haüy was placed at the head of it. Among the books which he embossed were a grammar, a catechism, and small portions of the Church Service, and also several pieces of music. The printing of the music was inferior. His principal work, on the subject of his invention, was published in Paris in 1786. This celebrated essay was translated into English by Dr. Blacklock, the blind poet, and published.

Twenty-four of Haüy's pupils exhibited their attainments, in reading, writing, arithmetic, music, and geography, before the unfortunate Louis XVI. and the royal family at Versailles, who were delighted with the

wonderful results. For a while all went on prosperously, but as the novelty wore away, the admiration of Mr. Haüy's friends cooled, the funds fell off, and the institution languished until it was put upon a government foundation. The blind really received but little advantage from an invention that at first promised so much. The fault, however, seems to have been not so much in the plan as in the execution of it. The books were bulky and expensive, and the letters, though beautiful to the eye and clearly embossed, wanted the sharpness and permanence essential to perfect tangibility. This noble invention, except, perhaps, within the walls of the institution, soon sank into oblivion, and very little more was heard of it until 1814, when Haüy was pensioned, and Dr. Guillié, an active and enterprising gentleman, was made director-general in his place. Dr. Guillié soon revived the printing, and having considerably modified the letters, commenced the publication of a series of elementary and other works—the mechanical execution of which was exceedingly heavy. Most of them were ponderous folios and very expensive, still they formed for many years almost the only literature of the blind, not alone in France, but in other countries. One of them—an historical notice on the instruction of young blind persons—contains a curious specimen of printing in relief, in colour, so as to render the letters more easily read by the eye. This book was a valuable contribution to the library of the blind, but it could only be read by those possessing a very delicate touch. It is filled with information respecting the means then employed for the instruction of the blind in Paris; it proves however, that the art of embossed typography had made

but very little progress. It is a reproach to this book that it makes no mention of the author's predecessor, Haüy, to whom the idea of finger-reading is due.

It was in Great Britain, and in the United States that the first improvements were made in embossed typography, and only within the last thirty years that the blind generally have derived any considerable advantages from books. Before 1826, when Mr. James Gall, of Edinburgh, first began to turn his attention to the intellectual and moral education of the blind, it is believed that not a single blind person in any public institution of this country or America could read by means of embossed characters. To Mr. Gall is due the credit of reviving this art. On the 28th of September, 1827, he published "A First Book for Teaching the Art of Reading to the Blind," which is believed to be the first book printed for the blind in the English language. Thus while printing for the blind, which only lately was considered merely a curious or doubtful experiment, it is now established beyond all question that books are true sources of profit and pleasure to them. Embossed books have rapidly increased, and happily blind readers have multiplied still more rapidly.

THE ROMANCE OF THE STOCKING FRAME.

ON the wall of a chamber in the old Hall of the Framework Knitters' Society of London, now pulled down; there stood, in the days of George II., an ancient painted

wood carving which must always have attracted the attention of visitors. It represented the arms of the Company, which consisted of a stocking-frame without the woodwork, with the figure of a clergyman on the one hand and that of a woman on the other, forming what are called the "supporters." This singular heraldic device related to the romantic story of the invention of the stocking-frame by the Reverend William Lee, a native of Nottinghamshire, in the reign of Queen Elizabeth. The anecdote has been variously told, but no version appears better authenticated than that collected about forty years ago by Mr. Henson, a journeyman knitter, who, living by his daily labour in the lace frame at Nottingham, devoted all his leisure time to self-cultivation and to collecting materials for a history of the craft of which he was a member. The story was gathered by him chiefly from the narratives of "ancient stocking-makers," who all gave a similar account, doubtless inherited through many generations of workers at the frame.

Lee, it is said, paid his addresses to a young woman in his neighbourhood, to whom, from some cause, his attentions were not agreeable; or as, with more probability, it has been conjectured she affected to treat him with negligence, to ascertain her power over his affections. Whenever he paid his visits, she always took care to be busily employed in knitting, and would pay little attention to his conversation. This conduct she pursued to such a harsh extent, and for so long a period, that the lover became disgusted, and he vowed to devote his leisure, instead of following the whims of a capricious woman, in devising an invention that should effectually supersede her favourite employment of knitting. So

sedulous was Lee in his new occupation, that he set aside everything to accomplish this new object of his attentions; even his sacerdotal duties were neglected. In vain did the lady now endeavour to reclaim him. All interests, all avocations, all affections, were absorbed in his new pursuit, from which he imagined he should realize an immense fortune. His curacy was despised, and at length abandoned, as beneath the notice of a person who had formed in his imagination such gigantic prospects. For many years afterwards the old stocking-makers, particularly those in London, were fond of dilating in their cups on the difficulties he encountered. He had watched his mistress with the greatest attention while knitting, and he observed that she made the web loop by loop, but the round shape which she gave to the stocking from the four needles, greatly embarrassed him in his notions of destroying her trade by making a whole series or course at once, having as many needles as loops. It seemed impossible to construct a machine to make a round web. Pondering in his mind on the difficulties of his task, during one of his visits he found her knitting the heel of a stocking, and using only two needles; one was employed in holding the loops while the other was engaged in forming a new series. The thought struck him instantly that he could make a flat web, and then by joining the selvages with the needle, make it round. From that moment his whole soul was devoted to the object which presented difficulties in that age, which nothing but enthusiasm could have overcome.

At the end of three years' study and patience, Lee was enabled to make a course upon the frame; but here new obstacles presented themselves. He wrought

with great facility the top, the narrowings, and the small of the leg; but the formation of the heel and the foot still embarrassed him. It is stated, that misled by the method of fashioning stockings by the knitting-needles, when he arrived at the length where the heels were to be formed, he worked the heels alone, and brought the instep by the hand under the hook of the needle previous to pressing; and that it was some months before he discovered the method of working them together. Perseverance at length crowned all his efforts, and the clergyman attained the height of his wishes, and became the first frame-work knitter.

The subsequent history of Lee is a pathetic record of struggles and injustice. When, after a long course of arduous experiments, he had succeeded in his object of knitting by machinery, he looked for the golden harvest which had flattered his imagination, as now very surely within his grasp. But on applying to the Crown for a patent he was absurdly refused it, on the ground that it would interfere with the means of subsistence of a great many poor persons to whom knitting by hand gave employment. Queen Elizabeth is said to have observed, by way of softening the refusal, "Had Mr. Lee made a machine that would have made *silk* stockings, I should, I think, have been justified in granting him a patent for that monopoly, which would have affected only a small number of my subjects; but to enjoy the exclusive privilege of making stockings for the whole of my subjects is too important to grant to any individual." Such were the erroneous notions of political economy prevalent at that period, even among those accounted as the wisest of their time. Although much

cast down at this, Lee did not abandon himself to despair. Confiding in the Queen's words, that, if he could only knit silk hose by his machine, he should have the patent, he now applied his mechanical ingenuity to a new object, and he obtained some encouragement from Henry Carey, Lord Hunsdon, a nephew of Anne Boleyn, and therefore a cousin of the Queen, who, in consideration of a share in the expected patent, not only engaged to advance funds, but probably to secure his interest, actually bound his son and heir, Sir William Carey, an apprentice to Lee; and thus, says the Nottingham mechanic, "the first framework stocking-maker's apprentice was a knight, and eldest son to a lord who was of the blood royal."

Lee's original stocking-frame had but eight needles to the inch, and was equal only to the production of worsted hose of the very coarsest sort. With even twice that number of needles silk hose could not be made by it of less weight than half a pound per pair; and what are called twenty-four gauge silk frames, having twenty-four needles in an inch, are now probably the coarsest silk frames used in England; but nothing daunted, Lee, with the help of his brother James, set to work to improve his invention with marvellous perseverance. After an experience of more than two centuries the finest frames made in the "insides" as they are termed, having "jacks" and "combs," contain sixty-four jacks in three inches. Lee, with the help of his brother James, attempted at once to make a frame having sixty in three inches, and that without "sléys," which was a later invention. His combs and "counters" were not cast, but wedged in, and his needles were soldered into

brass combs instead of being cast into pewter, as now practised. At length, having surmounted all obstacles, about the year 1595 he completed the making of plain silk stockings from what is called a "twenty gauge silk frame," having only "jacks," without "lead sinkers," an invention which might have excited wonder and admiration even in these days.

With the assistance of his noble patron Lee erected and set to work nine frames of this description; but the Queen was obstinately determined not to grant the patent, and the unfortunate inventor had no hope of securing the due reward of his toil unless he could keep the secret of his machine, which he took extraordinary pains to do. His apprentices and workmen were principally composed of his own relatives, who thought it so high an honour to belong to the new craft that they wore their working-needles with ornamental silver shafts suspended from a silver chain at their breasts—a mark of distinction which was preserved as late as the reign of Queen Anne; but for all this Lee reaped nothing but disappointment from his efforts; for scarcely had his nine frames been erected when, in 1596, his great supporter, Lord Hunsdon, died: as also, about the same time, the young lord who had been apprenticed to him. Reduced to despair, and it is said, almost to want, Lee determined to quit the country which had treated him so ungratefully; and in 1603 eagerly accepted an offer of the celebrated Sully, then ambassador from France, to remove with his brother and his workmen to Rouen. After several years' delay in setting up his frames in Rouen, Lee went to Paris to make more extensive arrangements with the Government, but here his evil

gains again awaited him. Sully had brought over the English inventor and his men, contrary to his own inclination and entirely in deference to the avowed wish of the wise King Henry IV., to introduce the silk manufactures into France; but scarcely had Lee arrived in Paris when the King was assassinated by Ravaillac; and thus the poor inventor's brilliant expectations were again at an end. His fortitude now forsook him, and he gave way to melancholy; he thought himself the most unfortunate of men. Alone, unprotected, in a foreign country, after twenty-two years' struggles, he sickened at the thought, and sent for his brother James from Rouën; but before he arrived the inventor of the stocking-frame died of a broken heart in the midst of strangers. This happened in the year 1610, the very year of the king's assassination.

After Lee's death his brother James and six more of the little band of artificers who had emigrated from England returned home, leaving two of their companions behind. It has been said that but for this, the valuable art might have been lost to this country; but there was one individual who knew the secret as well as any of them, who had declined to accompany them into their voluntary exile. This was a miller, named Aston, who lived at Thoroton, in Nottinghamshire—a man to whom the stocking-frame was subsequently indebted for many valuable improvements which ultimately gave rise to an extensive manufacture of stockings in England, not only for this country but for foreign nations.

A curious old painting, relating to Lee's story, originally belonged to the Stocking Weavers' Company, and was hung up in their hall. It represented a man

in a student's dress pointing to a stocking-frame, and addressing a woman who is engaged in knitting by the hand—the only process previously known. The original picture has long been lost, and is now known only through the medium of an engraving. According to the compiler of the catalogue of portraits in the Patent Museum, it bore the inscription, "In the year 1589 the ingenious William Lee, A.M., of St. John's College, Cambridge, devised this profitable art for stockings, but being despised went to France; yet of iron to himself, but to us and to others of gold, in memory of whom this is here painted."

WILLIAM HYDE WOLLASTON, THE ECCENTRIC DISCOVERER.

THE well-known natural philosopher, Dr. Wollaston, was a man of singular habits. He was accustomed to carry on his experiments with very few instruments, and in the strictest seclusion. Even his most intimate friends were never permitted to enter his place of study. Dr. Paris relates that a foreign philosopher once called on Wollaston with a letter of introduction, and, unaware of the philosopher's peculiarity, expressed an anxious desire to see his laboratory. "Certainly," was the reply; and the misanthropic doctor immediately produced a small tray containing some glass tubes, a simple blow-pipe or bent metal tube, worth a few pence only, two or

three common watch-glasses, a slip of platinum, and a few similar things.

It is also related that shortly after Wollaston had inspected a grand galvanic battery constructed by Mr. Children, he met a brother philosopher in the street. Seizing his button (which was, it appears, his constant habit when speaking of any subject of interest) he led the friend into a secluded corner, where, after looking carefully about him as if engaged in some strange mystery, he took from his pocket a tailor's thimble which contained a galvanic arrangement, and pouring into it the contents of a small phial, he instantly heated a platinum wire to a white heat.

This eccentric philosopher was born at East Dereham, in Norfolk, in 1766, and was the son of Francis Wollaston, a man of some eminence as an astronomer, who published a catalogue of the northern circumpolar stars. Dr. Wollaston was educated as a physician, and shortly after he came to London became a candidate for the office of physician to St. George's Hospital. Being defeated in this contest it is said that he declared in a moment of pique that "he would abandon the profession, and never more write a prescription." It is certain that he subsequently gave up the profession to devote himself entirely to experimental sciences. His name is connected with chemical discoveries of the highest importance. In 1804 and 1805 he made known palladium and rhodium, two new metals contained in the ore of platinum, and associated with osmium and iridium, discovered about the same time by Mr. Tennant. In 1809 he showed that the supposed new metal tantalum was identical with columbium, previously dis-

covered by Mr. Hatchett; and shortly before his death he transmitted to the Royal Society a description of his ingenious method of rendering platinum malleable, by which invention he is stated to have acquired more than thirty thousand pounds. He contrived a simple apparatus for ascertaining the power of bodies to refract light. His camera lucida furnished persons ignorant of drawing with an easy method of delineating natural objects. His periscopic glasses were found in every optician's shop, as well as his sliding rule for chemical equivalents, which made it easy in a moment to calculate the proportions of one substance necessary to decompose a given weight of another. Dr. Wollaston was also the first to demonstrate the identity of galvanism and common electricity, and the cause of the different phenomena exhibited by those principles.

Wollaston had a great objection to his portrait being taken, though there is one fine portrait, by Jackson, of the eccentric philosopher in the meeting-room of the Royal Society, the history of which is interesting. His family and friends knew his reluctance on this point; nevertheless Mrs. Somerville, the well-known authoress, who earnestly wished to possess a portrait of her friend, Dr. Wollaston, many times asked when he would sit for his picture, to which he had invariably answered, "Never." One day, however, when he was greeted with the same question he said, "It is evident that I must either forego the pleasure of coming to this house or submit; so I will submit." He added, "Let us separately write the name of the artist to be employed." This was agreed; and it turned out that both parties had named the same artist.

William Hyde Wollaston died on the 22nd of December, 1828, aged sixty-two. When he was nearly in the last agonies, from an extensive cerebral disease, some friend near observed, in a whisper, that he was not conscious of what was passing around him. The dying man, however, caught the words and motioned for a pencil and paper to write. When he returned them it was found that he had written down some rows of figures, forming a sum in addition, which he had cast up correctly.

OLD PREJUDICES AGAINST COTTON SPINNING.

WHILE so enormous a number of our working population look eagerly to the question of supplies of cotton, it is difficult to imagine the fact that, one hundred and thirty years since, the newly-introduced cotton fibre was popularly regarded as about to cause the ruin of Great Britain: Even the Legislature shared this belief, and actually passed an Act of Parliament in 1721 imposing a penalty of five pounds upon the weaver, and twenty pounds upon the seller of a piece of calico; and long after that date it was the fashion to attribute any special distress falling on the working-classes to this cause. Even criminals on the scaffold confidently appealed to the prejudice of the spectators, and assumed a high moral tone on this point, as appears from the following singular letter from "Cork, in Ireland," which appears under the date of May 3 in the "Gentleman's Monthly Intelligencer" for 1784:—

“This day one Michael Carmody was executed here for felony; upon which the journeyman weavers of this city (who labour under great difficulties by reason of the deadness of trade, occasioned by the pernicious practice of wearing cottons), assembled in a body, and dressed the criminal, hangman, and gallows in cotton, in order to discourage the wearing thereof; and at the place of execution the criminal made the following remarkable speech:—

“Give ear, O good people, to the words of a dying sinner. I confess I have been guilty of many crimes that necessity compelled me to commit; which starving condition I was in, I am well assured, was occasioned by the scarcity of money, that has proceeded from the great discouragement of our woollen manufactures.

“Therefore, good Christians consider, that if you go on to suppress your own goods by wearing such cottons as I am now clothed in, you will bring your country into misery; which will consequently swarm with such unhappy malefactors as your present object is; and the blood of every miserable felon that will hang, after this warning from the gallows, will lie at your doors.

“And if you have any regard for the prayers of an expiring mortal, I beg you will not buy of the hangman the cotton garments that now adorn the gallows, because I can't rest quiet in my grave if I should see the very things wore that brought me to misery, thievery, and this untimely end; all which I pray of the gentry to hinder their children and servants for their own characters' sake, though they have no tenderness for their country, because none will hereafter

“wear cottons, but oyster-women, criminals, hucksters, and common hangmen.”

The pernicious practice of wearing cottons has, happily for England, continued to extend itself in spite of Michael Carmody's bitter denunciations. Nearly fifty years afterwards, on the accession of George III., the value of all the cottons manufactured annually in England was estimated at £200,000. In 1860, the value of the cotton fabrics issuing from English looms was upwards of fifty-two millions sterling. It was the introduction of steam as the motive power of the spindles that gave the rapid extension of production and commerce which has distinguished the last half century. In 1823, Great Britain employed ten thousand steam-looms; the number at present in operation is nearly four hundred thousand, driven by a power of 294,000 horses, and directly employing nearly half a million of workpeople.

THE PHILOSOPHER TAUGHT BY THE CHILD.

The first scientific discovery made by Sir Humphrey Davy was due entirely to the observation of a little child. When a youth and eagerly curious on all phenomena connected with his favourite study, he was appealed to by this child to know why it was that when two pieces of bonnet-cane were rubbed together a little faint light came from them? If the fact had

ever been observed before it was at least new to the chemist's apprentice. Patting his little questioner on the head, he replied, "I do not know. Let us see if it is so; and then we will try and find out why." Experiment showed that the child had correctly observed the fact. The young philosopher pondered upon it, and perceived that the principle which it indicated must be of much wider application; and the train of inquiry which this set in motion gradually brought him to the discovery of the siliceous earth in the epidermis, or skin of reeds, and grasses.

With respect to this beautiful discovery, Davy observes in his "Agricultural Lectures," that this epidermis serves as a support, protects the bark from the action of insects, and seems to fulfil a part in the economy of these feeble vegetable tubes similar to that performed in the animal kingdom by the shells of the crustaceous insects.

HERSCHEL'S FIRST AND LAST TELESCOPES.

It is well known that William Herschel was in early life an organist at a chapel at Bath. He had to play incessantly either at the oratorios, or in the rooms at the baths, at the theatre, and in the public concerts, and he could not refuse the numerous pupils who wished to be instructed in his school. Nevertheless, he

found time to study mathematics, which, in their turn, led him to optics. At length, a simple telescope, only two feet in length, fell into his hands. This instrument (says M. Arago, in his brilliant sketch of this great astronomer, which we abridge for the benefit of our readers) showed him, however imperfect, a multitude of stars that the naked eye cannot discern; showed also some of the familiar constellations, but now under different aspects, and revealed to him forms that even the richest imaginations of antiquity had never suspected. He was filled with enthusiasm, and determined to have one of larger dimensions. But when the answer from London arrived, the price which the optician demanded proved to be far beyond the pecuniary resources of a mere organist. This unexpected difficulty, however, only inspired him with fresh energy. He could not buy a telescope, but he was determined to construct one with his own hands; and, after a multitude of experiments, perseverance at last received its reward.

It was in the year 1774 that Herschel had the happiness of being able to examine the heavens with a Newtonian telescope of five feet focus, entirely of his own construction. This success tempted him to undertake still more difficult tasks. Other telescopes of seven, of eight, of ten, and even twenty feet focal distance, crowned his efforts. Nature granted to the astronomical musician the unheard-of honour of commencing his career of observation with the discovery of a new planet, situated on the confines of our solar system, and now known by the name of Uranus. Dating from that moment, Herschel's reputation, no

longer in his character of musician; but as a constructor of telescopes, and as an astronomer, spread throughout the world.

Herschel was a native of Hanover, and George III., much inclined to protect and patronize both men and things of Hanoverian origin, had Herschel presented to him. He was charmed with the simple yet lucid and modest account that he gave of his repeated endeavours; ensured to him a pension of three hundred guineas a year, and, moreover, a residence near Windsor, first at Clay Hall, and then at the subsequently famous observatory at Slough. The hopes of the king were completely realized. The little house and garden of Slough became the spot of all the world where the greatest number of discoveries have been made. "The name of that village," says Herschel's enthusiastic biographer, "will never perish; science will transmit it religiously to our latest posterity."

Miss Caroline Lucretia Herschel went to England as soon as her brother became special astronomer to the king. She received the appellation there of assistant astronomer, with a moderate salary. From that moment she unreservedly devoted herself to the service of her brother, happy in contributing night and day to his rapidly increasing scientific reputation. Caroline Herschel shared in all the night-watches of her brother, with her eye constantly on the clock, and the pencil in her hand. She made all his calculations, made three or four copies of all the observations in separate registers, co-ordinated, classed, and analysed them. If the scientific world saw with astonishment how Herschel's works succeeded each other with unexampled rapidity during so many years, they

were specially indebted for it to the ardour of this lady. Astronomy, moreover, has been directly enriched by the knowledge of several comets through her labours. After the death of her illustrious brother, Miss Herschel retired to Hanóver, to the house of John D. Herschel, a musician of high reputation, and the only surviving brother of the astronomer. For some years Herschel enjoyed with delight the distinguished success of his only son, Sir John Herschel. At his last hour he sunk to rest with the pleasing conviction that this beloved son, heir of a great name, would not allow it to fall into oblivion, but adorn it with fresh lustre, and that great discoveries would honour his career also. No expectation of the illustrious astronomer has been there completely verified.

Our scientific journals gave some years since an account of the means adopted by the family of Herschel for preserving the remains of the great telescope constructed by the celebrated astronomer. The metal tube of the instrument, carrying at one end the recently-cleaned mirror of four feet ten inches in diameter, was placed horizontally in the meridian line, on solid piers of masonry, in the midst of the circle, where formerly stood the mechanism requisite for manœuvring the telescope. On the 1st of January, 1840, Sir John Herschel, his wife, their children, seven in number, and some old family servants, assembled at Slough. Exactly at noon the party walked several times in procession round the instrument; they then entered the tube of the telescope, seated themselves on benches that had been prepared for the purpose, and sang a requiem, with English words, composed by Sir

John Herschel himself. After their exit, the illustrious family ranged themselves round the great tube, the opening of which was then hermetically sealed. The day concluded with a party of intimate friends.

FIVE GUINEAS FOR A NEW PLANET.

THE elder Herschel was a man of kindly disposition; but like most persons who have risen out of early difficulties, he was extremely careful of money, and became wealthy. A traditional anecdote of his domestic life, however, shows that he could be good-humouredly generous on occasions. An old servant, named Betty, was with him at the time of constructing his telescope, and his first act on discovering the planet Uranus was to give her a guinea, adding, "You shall have five guineas, Betty, when I discover another." The poor woman accepted the promise in all seriousness, and great was her interest in all her master's subsequent labours. Planets, however, even by *Dr* Herschel, are not to be discovered every day, and Betty's hopes were long deferred. One day Herschel received a friend to whom he had previously told this story, with the exclamation, "I have paid my five guineas!" "What!" exclaimed the friend; "have we to rejoice over another great discovery?" "No," replied the astronomer, with a good-humoured smile; "I have simply paid poor Betty in

advance." "You see," he added, as his visitor appeared puzzled, "I often pursue these researches long after the good woman has retired to rest. How is Betty to know that I do not discover new planets clandestinely, and keep her from the knowledge with a mean determination to save my money? Better to pay at once; better to pay at once."

THE FATES OF JOHN KAY AND LEWIS PAUL.

station 61.

THE lives of our early inventors form almost one unbroken tale of persecution and disappointment. This is particularly exemplified in the stories of John Kay and Lewis Paul. From the earliest ages the loom had remained without improvement, and the spinners and weavers at the beginning of the last century used practically the same machines as were employed by the Egyptians for the manufacture of those linen cloths, of which we have still specimens wrapped round the bodies of the mummies in the British Museum; when in 1735 Kay, the son of a woollen manufacturer at Bury, in Lancashire, produced the fly shuttle, thereby at once reducing the labour of weaving by more than one half. Kay was a well-educated man, and had been on the Continent, on his return whence he settled at Colchester, and there conducted a woollen manufactory; but the weavers of that place rose against him and drove him from the town. He then, in 1738, established himself as an en-

gineer at Leeds. Here, however, he was still more unfortunate; for although the clothiers of Yorkshire were not unwilling to adopt the fly shuttle, they refused to pay for its use, and he was driven to the Court of Chancery to protect his rights. The manufacturers formed an association to oppose his claims, which they impudently denominated The Shuttle Club, the avowed purpose of which was to defraud him of his just remuneration. The workmen, too, rose against him, and by their violence compelled him to close the workshops. Once ~~made~~ a wanderer, he settled at his native place at Bury; but here, in 1753, a lawless and ignorant mob broke into his house, destroying everything they found, and would have killed him if he had not been conveyed to a place of safety by two friends, wrapped in a wool sheet. A few years later, having in vain sought assistance from the Society of Arts, he fled in disgust to France, where, however, he was encouraged by the British Ambassador to return to England in the hope of some reward from our Government, for the immense benefits which his inventions had bestowed on his countrymen. Disappointment was again his portion. Baffled on all sides and hopelessly crushed in spirit, the unfortunate "reed-maker," as he styled himself, returned to Paris, where he died in poverty and obscurity—no stone telling where he lies. His daughter, the companion of his misfortunes and the solace of his last days, was afterwards compelled to take refuge in a nunnery.

Bury, says Mr. Bennet Woodcroft, has produced two great men—John Kay, the inventor, and Sir Robert Peel, the statesman. To the latter, the inhabitants have already erected a statue; to the former they have

still to do that act of justice. Kay's improvements in machinery for weaving continue in use up to the present time in tens of thousands of looms in this kingdom for making cloths of silk, cotton, linen, and woollen.

Lewis Paul's history, though less tragic, was scarcely less marked by misfortune. His name is almost forgotten, and the glory of his ideas absorbed in the more successful modifications of the more fortunate Arkwright. At the very time when the mob were driving Kay out of Colchester, Lewis Paul patented a machine which superseded the ancient hand-wheel for spinning, and adopted the method of spinning by the aid of bobbins. He was the son of a ~~Dr. Paul~~, a man of some eminence; but almost all that is known of his history is derived from two letters, still extant, addressed by him to the Earl of Shaftesbury, under the guardianship of whose father he appears to have been placed in early life. He confesses that he made but an ill use of his fortune; but says, that before the calamities of which he had laid the foundation had reached him, he had exerted himself to repair his affairs with such ardour and success that "notwithstanding the impediments necessarily in the way of a person who had spent his time, in every circumstance, so remote from the arts of trade, he nevertheless completed a machine of great value in one of the most extensive manufactories of the kingdom;" and he adds, that "in something more than the course of twenty years it gained him £20,000 as patentee." He complains of cabals and enmities, and of rivalry of manufacturers, to which he attributes his subsequent misfortunes. The first patent for spinning granted to Paul was dated 24th June, 1738, and was for fourteen years. It expired in 1752, and,

singularly enough, it does not appear that the rollers were afterwards carried on under it.

Dr. Johnson was intimately acquainted with Paul, and befriended him in various ways. A great number of letters between them have been published, and one preserved in the Patent-office, Johnson suggests to him a mode of obtaining money from Mr. Cave, the printer of the "Gentleman's Magazine," to carry on his spinning experiments. The specification of his first patent explains that when the cotton or wool is prepared, "one end of the sliver is put between a pair of rollers, or cylinders, or some such movement, which, being turned round by their motion, draws in the mass of cotton to be spun in proportion to the velocity given to the rollers. As the cotton (it adds) passes regularly through or betwixt these rollers, a succession of other rollers, moving proportionally faster than the first, draw the sliver into any degree of fineness that may be desired." The poet Dyer, the author of "Grongar Hill," in his poem of the "Fleece," in 1757, described the same operation with more nicety of detail than poetic fire, as follows:—

"A circular machine, of new design,
In conic shape; it draws and spins a thread
Without the tedious toil of needless hands.
A wheel, invisible, beneath the floor,
To ev'ry member of th' harmonious frame
Gives necessary motion. One, intent,
O'erlooks the work; the carded wool he says
Which, gently turning, yield it to the
Of upright spindles, which, with rapid
Spin out in long extent, an even twine."

INVENTION AND DISCOVERY.

might well pass for a description of a spinning-machine of these days; but the fact that after being extensively adopted it fell into total disuse, clearly shows that Arkwright's machine must have been so much superior as to entitle it to be considered original. Lewis was born in 1759, at Brook Green, Kennington, and was buried at Paddington.

TROUBLESOME PERSON IN CHEMISTRY.

A WRITER in the "North British Review," tells an amusing story, illustrative of the unwillingness to receive new truths which is characteristic of some minds. Long after Sir Humphrey Davy had become famous in London circles as the "young chemist," who attracted larger audiences to his lectures at the Royal Institution than perhaps any purely scientific man had ever done before, there was a certain professor of chemistry in the college at Aberdeen, who systematically passed over his discoveries. Some bolder spirits among the Doctor's colleagues at length aroused his attention to the subject, and the Professor was compelled to take notice at last of Davy's great discovery of potassium. Accordingly at his next lecture he began by saying, "Gentlemen,—potash and soda are now said to be metallic oxides,—the oxides, in fact, of two metals, called potassium and sodium. Both discovered by them,—one, Davy, in 1808, the other, Berzelius, in 1828."

"PARSLEY" PEEL.

THE founder of the Peel family, and the father of the first baronet, kept a skilled mechanic in his cotton printing establishment, for the purpose of carrying out his ideas in the improvement of machinery. This man, we are told by Sir Lawrence Peel, was kept concealed in the private house of a Mr. Haworth at Brookside, near Blackburn, where he worked in secret, as if he was engaged in some mysterious wickedness. In the course of his experiments Mr. Peel also introduced some improvements in the printing of the cottons; in connection with which a story is still current in the Peel family. This ingenious manufacturer was in his kitchen one day, making some experiments in printing on handkerchiefs, and other small pieces, when his only daughter, then a girl, afterwards Mrs. Willock, the mother of the postmaster of Manchester, brought him in from their garden a sprig of parsley. It was some proof of taste in so young a girl (says Sir Lawrence) that she could discern beauty in a common pot herb, which is generally regarded as created only for a garnish or a fry. She pointed out and praised the beauty of the leaf, and looking, by the habit of the remarkable family to which she belonged, naturally to the useful side, she said that she thought it would make a very pretty pattern. Her father took it from her hand, looked at it attentively, praised her for her taste, and said that he would make use of it. He, delighted not to be pooh-poohed, as so many others among young folks often are, lent her aid in the

ingenuity of a girl of fourteen. A pewter dinner-plate—for such was then the common dinner-plate of families of their degree—was taken down from the shelf, and on it was sketched, or scratched, a figure of the leaf, and from this impressions were taken. This was called in the family, “*Daisy’s pattern*,” after the little girl who invented it. It became one of the most popular patterns in cotton cloth ever designed, and was at one period as widely known and as universally used as the “*Willow pattern*” in crockery ware. It may be said that it had no small share in laying the foundation of the fortunes of the Peel family. In the trade it was everywhere spoken of as the *Parsley leaf pattern*, and alliteration lending its aid, the fortunate father of the shrewd young lady became generally known by the nickname of “*Parsley Peel*.” ..

THE EARLIEST UMBRELLA.

It is generally stated that Jonas Hanway, the well-known philanthropist, was the first man who carried an umbrella in the streets of London. Hanway died in 1786. Early in the century a large umbrella was kept in the halls of aristocratic mansions for the special protection of the lady of the house in passing from her door to her coach; and it was not uncommon to keep such articles in the coffee houses or taverns for the benefit of customers as early as Queen Anne’s reign. The fact, however, is not the less true, that it is only

within the lifetime of persons now living that this almost indispensable protection from the moist climate of England has become generally adopted. In the "Female Tatler," of December 12, 1709, appears a satirical notice informing the "young gentleman belonging to the custom-house who, for fear of rain, borrowed the umbrella at Will's coffee-house, in Cornhill, of the mistress," that "to be dry from head to foot on the like occasion he shall be welcome to the maid's pattens." Gay mentions the umbrella as early as 1712, in his poem of "Trivia," in which he describes the "tucked-up sempstress" walking in a shower while streams "run down her oiled umbrella's sides." Mr. J. Jamieson, a Scottish surgeon, brought with him from Paris in 1781, or 1782, an umbrella which was the first seen in Glasgow where he resided, and where it attracted universal attention.

The earliest specimens of the English umbrella were made, as mentioned in Gay's lines, of oiled silk, which, when wet, was exceedingly difficult to open or close. The stick and furniture were heavy and inconvenient, and the article very expensive. Its transition to the present portable form is due, partly to the substitution of silk and gingham for the heavy and troublesome oiled silk, which admits of the ribs and stretchers being made much lighter; and also to the many ingenious mechanical improvements in the framework which have been made from time to time, chiefly by English and French manufacturers, several of which have been patented. No change has proved a greater convenience than that from the old-fashioned ring and string, for securing the umbrella when closed, to the simple clip and

India rubber braid now in use; and yet, before this was accomplished, many transitions had to be passed through.

Though the umbrella is itself of older date, there is nothing to invalidate the story that it is to the good Jonas Hanway that we are indebted for the valuable example of moral courage in first carrying an umbrella in the streets of London. It is difficult now to conceive the amount of persecution which this strange proceeding entailed upon the unfortunate philanthropist, whose object was, doubtless, less the protection of his own person than that of showing his fellow-countrymen how they might avoid those continual drenchings to which they had so long submitted. The hackney coachman and the sedan chairman were the first to call out against the threatened innovation, declaring that they were ruined if it came into fashion. When they began to be carried, even a gentleman accompanied by a lady, under the shelter of the new-fangled rain protector, were hooted as they passed along; while a gentleman alone, carrying one, was certain to be attacked with cries of "Frenchman! Frenchman! why don't you call a coach?" and other more offensive salutations.

THE OLD TELEGRAPHS.

—o.o.o.—

AMONG the still primitive people of Montenegro a plan of transmitting information prevails which may be considered the rudest system of telegraphy still existing. When a shepherd in the mountains finds himself in want of society, he sends out at random a peculiar kind of yell with a view of attracting the attention of any one similarly situated who may chance to be within hearing upon some other mountain side, and may also feel a desire for conversation. It is well known at what a great distance shrill sounds may be distinctly heard in these mountainous regions. The unseen friend, whose ears have caught the sound, responds in the same way, and then begins a dialogue about their flocks and herds, or any other country gossip; and should there chance to be news of public interest, such as of any important person or foreigner passing that way, the receiver of the intelligence shouts it out in the open air for the benefit of the mountain nearest to him, and so it passes from one to another through a considerable part of the country. "This practice of calling from hill to hill," says a recent traveller, "also answers the purpose of an advertisement in a newspaper, and that with wonderful celerity. At any given time one half of this badly-housed population may mostly be found in the open air, and their ears are astonishingly quick at catching these sounds. Any one who yells out his requirements may generally calculate on some one who has nothing else to do repeating them for him to the next living

telegraph." An acquaintance told me he was once in want of a mule that was at the time grazing in the mountains more than ten miles off. He accordingly began the hue and cry. 'Ho! ho! you people there in the village of Brelizzu! High up in the mountains of Glontotich, by the great beech tree with the withered boughs, my little lad Yonko is keeping my white-footed mule. Let him know that he is to come with it down to the road as fast as he can.' Thus the owner of the mule yelled at random into the air, and immediately some living echo took up his words, repeating them exactly; and so the message went till it reached the boy, and the owner of the mule found it waiting for him at the appointed place."

Beacon fires were the ancient mode of telegraphy adopted in Great Britain, and in an act of the Scottish Parliament of 1455, it is directed that "one bale or faggot shall be warning of the approach of the English, in any manner, two bales that they are coming indeed, and four bales blazing beside each other, that the enemy are in great force." The famous Bishop Wilkins, who pretended to discover the art of flying, describes certain alphabetic systems of transmitting information which depended merely upon the number and alternate display or concealment of lights. The Marquis of Worcester, in 1663, described a system by which, as he said, a man at a window, as far as the eye could discover black and white, could hold discourse with his correspondent; and the ingenious Dr. Hook, in 1684, explained to a meeting of the Royal Society a scheme for communicating one's mind at distances of thirty, forty, a hundred, or a hundred and twenty miles "in as short a time

almost as a man can write what he would have sent. His plan required the use of the telescope, and was of course dependent on weather and various accidents; but this was the germ of the old semaphore which was actually used by our Government, and was at work in this country as late as 1852 between Liverpool and Holyhead. About twenty years after Hook's scheme was unfolded, an inventor, named Amontous, brought forward a similar plan in France. Persons were placed by him in several stations at a certain distance from one another, and by the help of a telescope a man in one station was enabled to see a signal in the next before him. He was then required immediately to make the same signal, so that it might be seen by persons in the station after him. The signals used were either large letters of the alphabet or figures of various shapes to represent them. Amontous publicly demonstrated the practicability of his plan; but no system of signals was applied to any useful purpose till the period of the French Revolution. The telegraph then brought into use, in either 1792 or 1794, was the invention of M. Chappé, and, though similar in principle to the machine invented by Hook, it was greatly superior. The roof of the Louvre was his telegraphic terminus, and Chappé, having received from the Revolutionary Government a message to be forwarded to the army at Lille, he gave an understood signal to the heights of Montmartre, which was the second station, to prepare. At each station there was a watch-tower where telescopes were fixed, and the person on watch gave the signal of preparation throughout the line. The watcher at Montmartre then received, letter by

letter, the sentence from the Louvre, which he repeated by his own machinery, and this was again repeated from the next height with as much rapidity as possible, until the message arrived at Lille. The upright post which was erected on the Louvre had at the top two transverse arms, moveable in any direction by a single piece of mechanism. Chappé invented a number of positions for these arms, which stood as signs for the letters of the alphabet, and even these were reduced as much as possible. The signs too were arbitrary, so that they could be changed every week, all that was necessary being that the persons at each terminus should have the key. Two working models of this instrument were made at Frankfurt, and sent by Mr. W. Playfair to the Duke of York, and thus the plan and the alphabet of the instrument came to England. Chappé was not more fortunate than other inventors in escaping opposition and discouragement. The people were prejudiced against the new machinery. His first instrument and station were destroyed by the populace; his second was burned to the ground, the unfortunate inventor narrowly escaping from the mob with his life; but the telegraph was subsequently taken up by the French Government, and became extensively used on the Continent.

This kind of telegraph, known as the aerial, was first established in England seventy years ago, a line of stations being formed from the Admiralty at Whitehall to the sea-coast, and information was thus conveyed from London to Dover in ten minutes. The expense of working and mounting the line from London to Portsmouth was three thousand three hundred pounds per

anum. Though of great service to the Government, this old cumbrous system was of course only available in clear weather. Vexatious interruptions continually took place, and droll accidents occasionally resulted from the sudden cessation of communication, from a fog or similar cause, during the transmission of a message. When the British army were fighting under Wellington in Spain, news were anxiously expected from that great commander through the Admiralty signals. The public were in a state of feverish excitement, when one day the disastrous message was received, "Wellington defeated." The funds were violently agitated, the people and the Government were bewildered, and terrible rumours of enormous slaughter and great loss of guns, colours, and ammunition were heard on all sides. It turned out, however, that, just as the word "defeated" had been deciphered at some part of the line, a sudden mist had come on and cut off the remainder of the message. When this inopportune visitor had passed away, the public mind was instantly relieved with the news that the message was not "Wellington defeated," but "Wellington defeated the French."

THE HISTORY OF MATCHES.

BEFORE the year 1820, scarcely any other method of producing fire was known than that of the old flint, steel, and tinder-box; that once familiar trio which can scarcely yet be said to be entirely out of use in England. As early as the middle of the seventeenth century, however, the discovery of phosphorus had indicated a more certain means of procuring light or fire, and in 1677 Daniel Krass, a famous German chemist, exhibited in England some striking effects produced by this new agency. It is believed that some trial was made as to whether an ordinary match could be ignited by its agency; but it is remarkable that the philosopher Boyle, described it only as "a factitious, self-shining substance," procured but in very small quantities, and with great labour and time, the principal value of which was to supply a light in the night, or in dark places when exhibited in glass vessels. It was about forty years ago, that a German, named Doebereiner, made the curious discovery that thinly divided or "spongy" platinum will inflame a mixture of hydrogen gas and atmospheric air, and hence invented his instantaneous light apparatus, first known by the name of the hydrogen lamp. This was greatly admired at the time, and is even now frequently employed; it having been applied to light an ordinary gas burner, required to be lighted at intervals during the day time, for the purpose of sealing parcels.

About the same period, several methods of obtaining light by means of phosphorus were proposed; but they

were generally more ingenious than practical. In one case equal quantities of phosphorus and sulphur were fused together in a glass tube, which was subsequently closed with a cork. On opening the tube, if a splinter of wood was dipped into the mass, so that a small quantity of the composition adhered to it, it became ignited when slightly rubbed on the cork used to close the phial. This apparatus soon became entirely obsolete.

The first great practical improvement in the means of obtaining light consisted in covering the end of a match which had previously been dipped in sulphur, with a mixture of sugar and chlorate of potash, which being steeped in sulphuric acid communicated the inflammation to the underlying coating of sulphur. These matches we believe to have been introduced from France; but before this, Captain Manby, feeling the necessity of being able to obtain an instantaneous light for the firing of his well-known rocket for conveying a rope to a stranded ship, had been accustomed to employ a similar mixture. The same principle was involved in the manufacture of the so-called "Promethean" matches, invented by Mr. Jones of the Strand. These matches were made of a roll of paper, in one end of which was placed a portion of the mixture above described, with a small tube hermetically sealed, similar to those in which the leads of ever-pointed pencils are preserved, and containing a minute quantity of strong sulphuric acid. By pinching the end of the match with a small pair of pliers sold for the purpose, the tube was crushed, and the sulphuric acid came in contact with the mixture and ignited it. These matches, though convenient, were very expensive; and the popular thin wooden box of matches,

now so familiar, and sold for a halfpenny, was still undreamed of. The first true friction matches, known as lucifers (a Latin word, signifying "light bringers"), were coated with a mixture of sulphide of antimony and chloride of potash, made into a paste with gum-water, and were lighted by drawing them rapidly between the two surfaces of a square piece of folding sand paper. From this somewhat cumbrous and inconvenient device, the public were finally relieved about the year 1834, when the present "Congreve" match was introduced "nearly simultaneously" in various countries. The secret of these was the substitution of Boyle's "factitious shining" substance—phosphorus—for sulphide of antimony; but to whom the credit of this useful idea is due does not appear. On the Continent the progress in adopting the match was very slow, its use having been positively prohibited in various countries, on account of the assumed danger of fire; but in England the cheapness to which it was speedily reduced, soon drove out, not only the old tinder box, but even the really useful lucifer match.

DAVY AND THE "LAUGHING GAS."



THE dangers which enthusiastic men of science will voluntarily undergo for the sake of testing new principles have never been more strikingly exemplified than in the history of Sir Humphrey Davy's early experi-

ments on the effect of nitrous oxide, popularly known as "laughing gas." Davy began his chemical studies in March 1798, when a youth of eighteen, and only two years later appeared his "Researches," which immediately gave him high rank, not as a mere chemist, but as an original discoverer. Herein, for the first time, the properties of nitrous oxide and the wonderful effects of that gas in respiration were disclosed to the astonishment of the public. Hitherto it had been regarded among natural philosophers with a sort of vague horror, and from its deadly effects upon small animals it was suspected that it was the very principle of the plague itself, that terrible visitation which, from time to time, swept over Europe. Nothing daunted by this, the young philosopher boldly resolved to try its effects upon his own system. He could not have been ignorant of the terrors of Spallanzani's experiments upon the gastric juice, and only a short time before the brave Pelletier, the French chemist, had lost his life in the attempt to breathe another kind of poisonous gas. But the boy philosopher thought it necessary to compare the effects of nitrous oxide with those of common stimulants, and he was resolved to pluck knowledge out of this dangerous trial. With this view, he shut himself up, and first submitted himself to intoxication so extreme as to produce distressing and even alarming symptoms. To ascertain the effects of an atmosphere containing large quantities of the same gas, he enclosed himself in a box, and at three successive intervals, for an hour and a quarter (during which time he remained in the box), had sixty quarts of the gas thrown in finally constituting a large proportion of the air which

he was breathing. When the last twenty quarts were thrown in his emotions became similar to those produced by a moderate dose of the pure gas; but, not satisfied with this, immediately after coming out of his cage, he began to breathe in twenty quarts of nitrous oxide, probably the most effectual trial ever made of this wonderful agent.

"A drilling" (he observes, in his own account of this audacious experiment), "extending from the chest to the extremities, was almost immediately produced. 'I felt a sense of tangible extension highly pleasureable in every limb; my visible impressions were dazzling and apparently magnified; I heard distinctly every sound in the room, and was perfectly aware of my situation. By degrees, as the pleasureable sensations increased, I lost all connection with external things; trains of vivid, visible images rapidly passed through my mind, and were connected with words in such a manner as to produce perceptions perfectly novel. I existed in a world of newly-connected and newly-modified ideas. I theorized; I imagined that I made discoveries. When I was awakened from this semi-delirious trance by Dr. Kinglake, who took the bag from my mouth, indignation and pride were the first feelings produced by the sight of the persons about me. My emotions were enthusiastic and sublime, and for a minute I walked round the room perfectly regardless of what was said to me. As I recovered my former state of mind I felt an inclination to communicate the discoveries I had made during the experiment.' I endeavoured to recall the ideas; they were feeble and indistinct. One collection of terms, however, presented itself, and with the most

intense belief and prophetic manner I exclaimed to Dr. Kinglake, 'Nothing exists but thoughts!—the universe is composed of impressions, ideas, pleasures, and pains!'

The impunity with which Davy had passed through these wonderful trials emboldened him to attempt the breathing of the deadly fumes from charcoal. His first attempt was made upon four quarts of carburated hydrogen gas, of which he made three inspirations. "The first inspiration" (he tells us) "produced a sort of numbness and loss of feeling in the chest and about the pectoral muscles. After the second inspiration I lost all power of perceiving external things, and had no distinct sensation except a terrible oppression on the chest. During the third inspiration this feeling disappeared; I seemed sinking into annihilation, and had just power enough to drop the mouthpiece from my unclosed lips. A short interval must have passed during which I respired common air before the objects about me were distinguishable." On recollecting himself, he faintly articulated, "I do not think I shall die." Putting one finger on his wrist, he found his pulse threadlike, and beating with excessive quickness. Extreme giddiness, loss of memory, and numbness succeeded, with excruciating pains in the forehead and between the eyes, and transient pains in the chest and extremities.

Davy was, as far as his philosophical learning went, entirely self-instructed. He was born at Ponzance, in Cornwall, on the 17th of December, 1778. Though some attempt has been made to conceal the fact, there is no doubt that his father, Robert Davy, followed the humble occupation of a wood-carver. He was known

in that town as "little Carver Davy," and his son, when young, was always spoken of there as "Carver Davy's boy." His father dying when the lad was only sixteen, his mother commenced the business of a milliner, and apprenticed her child to an apothecary at Penzance, where, for the first time, he began to show an interest in his favourite study.

"His means, of course," says his brother, Dr. Davy, "were very limited; not more extensive than those with which Priestley and Scheele began their labours in the same fruitful field. His apparatus consisted chiefly of phials, wine-glasses, teacups, tobacco-pipes, and earthen crucibles, and his materials were generally the mineral acids and the alkalis, and some other articles which are in common use in medicine." He began his experimental trials in his bedroom, in a friend's house, in which he was a favourite inmate. Here there was no fire, and when he required it he was obliged to come down to the kitchen with his crucible. His biographer, Dr. Paris, states that Davy was indebted to the accident of a wreck on the coast for a case of surgical instruments. This included a clumsy clyster apparatus, which he turned into an air-pump. The sacred vessels and professional instruments of the surgery were, without the least hesitation, put into requisition for any chemical experiments.

It can hardly be doubted that Sir Humphrey Davy's constitution, which was so vigorous in youth, withered and decayed long before he had reached old age from the effects of injuries sustained by these early experiments. He died in 1829, at Geneva, of an attack of apoplexy, but his end was singularly peaceful. When

his brother, Dr. Davy, entered the room, Sir Humphrey said, "I am dying," or words to that effect. "When it is all over, I desire that no disturbance of any kind may be made in the house. Lock the door, and let every one retire quietly to his apartment." The mortal remains of Carver Davy's son, the great philosopher and discoverer, were honoured with a public funeral, and deposited in the cemetery without the walls of Geneva.

POPULAR NOTIONS OF INVENTIONS.

WHEN the electric telegraph wires began to be worked along our lines of railway, scientific men were amused by the absurd notions entertained of them, not only by the country people, but even by public writers. One editor inserted a leading article commenting in the following strain on the telegraph between London and Yarmouth:—

"It is a fact, which some of our readers may be ignorant of, that sparrows and other small birds which happen to perch on those mysterious lines of communication, the telegraph wires, are destined ever and anon to suffer severe shocks of electricity, the effect of which is (though we never witnessed the phenomenon) that they drop down, not dead, but half dead, with amazement and terror. The shock, if severe enough, will destroy them. Electricity can be administered in doses which would kill a horse. Perhaps, by transmitting

through the telegraph wire a very powerful charge, the unhappy sparrows along the whole line, from London to Yarmouth, might be cut off. "This," in case of necessity, or as a matter of cruel curiosity, might be employed as a means of getting rid of these vermin. It is not uncommon or extraordinary to see at least a hundred of these feathered depredators on one mile of wire. The length of the whole line of which we speak is 146 miles. A shock strong enough to destroy sparrow-life would, with these data, cut off from the land of the living, at one fell and fatal swoop, not less than 14,600 of these little creatures. One thousand miles of railway would in like manner, and with the same conditions, be the death of 100,000. Even supposing that death does not ensue, yet how miserable will be the state of these little animals when the whole island is covered with a veritable network of telegraphic wires! Fatal twigs these for tiny feet! The whole family of sparrows will be paralyzed. The fowls of the air will be electrified. People, as they talk with each other, and whisper to each other in unheard communion, at the distance of 1000 miles, will be causing serious inconvenience to the feathered race. We tremble to think of the consequences, and heartily recommend the case to the Society for the Prevention of Cruelty to Animals. Dog-carts sink into insignificance when compared with this wholesale palpitatio—this universal twittering and consternation—among the feathered tribes. How many a sweet song will be interrupted—how many a little throat silenced—very suddenly indeed, when this mischievous machinery shall be brought into universal play!"

We need hardly inform the present generation of

readers that this amusing specimen of ignorance is founded upon an erroneous conception of the laws of electricity; and that no bird or other creature, unless its body formed part of the chain of communication, could be affected in any way by the passage of the electric fluid. Among other odd popular notions was that of the country people who thought that the humming noise made by the wind in passing through the wires was caused by the messages passing. Some believed they could tell when a train was coming by the noise. In one case, where a man's house was injured by lightning in the immediate vicinity of the line of telegraph, he conceived the calamity attributable to its influence; but, on careful investigation, in conjunction with a resident director, it satisfactorily appeared that the agency of the line was exactly opposite to that supposed by the injured party, and that, to the extent of the capacity of the wires as an electric conductor, it had alleviated and carried off the atmospheric charge from the point of its explosion in the vicinity of the injured house. It was found difficult to persuade the country folks that parcels or missing umbrellas could not be forwarded by the wires.

At Dover, an individual presented himself at the telegraph office one afternoon with a sum of money, and desired the clerk to send the money itself, in *propria forma*, up to London by telegraph, to be forwarded to a certain banker's. The money was to take up a bill due that day, and there was no time to send it by train. He seemed perfectly surprised that it could not be sent. At the terminus of the South-Eastern Railway in Tooley Street, a servant in livery came to the office, heated and out of breath, with a small parcel to be sent by telegraph

to a distant part of the country. It appears he had instructions to send it by train; but he arrived just too late for the train, and, as it was of consequence, he thought he should get out of his dilemma and expedite matters by adopting this course.

THE FIRST MARGATE STEAM-BOAT.

It is exactly fifty years since Brunel steamed down the river Thames on a voyage to Margate in a vessel propelled by a double acting marine steam-engine. Arrived at Margate, the engineer looked out for accommodation for the night. But this proved to be a difficult matter. The inhabitants were in arms against the inventor, who threatened to bring steam communication to their town, a feeling which was not confined to the persons connected with the sailing packets, but was even extended to the shopkeepers and lodging-letters. So blind were they to the future advantages of that mode of conveyance, which has since given so great an impulse to sea-coast watering places, that the landlords of hotels where Brunel desired to stay for the night absolutely refused to provide him with a bed. Many years afterwards, when Brunel was in the Isle of Thanet laying out a plan for a railway to Ramsgate, he wrote from Margate to a friend:—"To-day, by mere chance, I am at the York Hotel. It was at this same hotel that, in 1814, I was refused a bed because I came

by a steamer, and every one of the comers met with a very unfriendly reception. If they knew at this moment that I came to carry off the cargoes of the steamers to Ramsgate, I might probably share the same fate." Had he lived longer, Brunel might have seen the town of Margate with two lines of railway connecting it with London, and with its immediate rival Ramsgate, and assuredly no hotel-keeper in that neighbourhood would now deny that the engineer knew their interests better than they themselves. It is pleasing to think that this pioneer of steam navigation lived to see the launch of the "Great Britain" at Bristol, in 1843—a steamer of 3500 tons burden—in which the screw-propeller, which he had himself suggested in early life, was for the first time applied to a vessel of large burden.

WATT'S EARLY STRUGGLES.

WATT's first experiments in steam were undertaken when he was about twenty years of age, and while he was living in a little room within the precincts of the college at Glasgow, where he earned a bare subsistence by obtaining odd jobs as a mathematical instrument maker. Driven out of the city by the severe restrictions of the Trade corporation, against workmen who had not served an apprenticeship to their craft, some friends in the university had given him a refuge where he could be allowed the poor privilege of earning bread by the labour of his hands. A few apothecaries' phials,

and the instrument known as a Papin's digester, were at first his only tools. Next he obtained from the college to repair a model of one of Newcomen's engines, which he eagerly studied; but this was so clumsy a contrivance that the instrument maker regarded it merely as "a fine plaything;" and indeed this crude machine had hitherto been applied to no purpose, as a mechanical power, ~~except~~ that of pumping water from a few mines. Watt, in his own account of his experiments at this time, said:—"One Sunday afternoon I had gone to take a walk in the Green of Glasgow, and when about half way between the Howl's House and Arn's Well, my thoughts having been naturally turned to the experiments I had been engaged in for saving heat in the cylinder, *at that part of the road* the idea occurred to me, that, as steam was an elastic vapour, it would expand, and rush into a previously exhausted space; and that, if I were to produce a vacuum in a separate vessel, and open a communication between the steam in the cylinder and the exhausted vessel, such would be the consequence."

By much patience and industry Watt improved the boiler of this engine; but his ignorance of the principle of latent heat, and want of experience in the practice of mechanics, clogged his progress. No mechanics could then be found in Glasgow capable of making his large models; ignorant blacksmiths and tinmen being the only hands available. Poor as he was, Watt contrived to hire a small workshop in a back street of the city, where he himself erected a working model with the aid of his assistant John Gardiner. But while he was busied with his task his best mechanic died, and Watt,

who said at this time that he was "quite barren" of every other subject, his whole thoughts being bent on this machine, wrote to a friend, "My old white-iron man is dead—an almost irreparable loss." It was on the 5th of January, 1769—the same year in which Arkwright obtained the patent for his spinning machine, that Watt took out his patent for his steam, or as he called it, fire-engine; but his models were ill made; his resources were small; his health and spirits continually breaking down under the cares and anxieties of his life. He was often near abandoning altogether his ingenious schemes. In 1769, his spirit being embittered by hearing of an attempt to appropriate his inventions, he wrote to a friend:—"I have resolved, unless these things that I have now brought to some perfection reward me for the time and money I have lost on them, if I can resist it, to invent no more. Indeed, I am not near so capable as I once was; I find that I am not the same person that I was four years ago, when I invented the fire-engine, and foresaw, even before I made a model, almost every circumstance that has since occurred. I was at that time spurred on by the alluring hope of placing myself above want, without being obliged to have much dealing with mankind, to whom I have always been a dupe. The necessary experience was wanting; in acquiring which I have met with many disappointments. I must have sunk under the burthen of them if I had not been supported by the friendship of Dr. Roebuck. I have now brought the engine near a conclusion, yet I am not in idea nearer that rest I wish for than I was four years ago. However, I am resolved to do all I can to carry on this business. and if it does not thrive with me I

Will lay aside the burthen I cannot carry. *Of all things in life there is nothing more foolish than inventing.*" And on the 31st of January, 1770, he said:—"To-day, I enter into the thirty-fifth year of my life, and I think I have hardly done thirty-five pence worth of good in the world; but I cannot help it." Such was the desponding view taken by this great benefactor of mankind of those labours by which his name has since been rendered so famous. His subsequent removal to Birmingham, and his partnership with Mr. Boulton, opened a new and happier era for the dreaming maker of instruments, who now became a practical maker of engines on a large scale. The Soho works speedily became famous all over England. Yet, in 1780, Watt and Boulton were still out of pocket by his inventions, and as late as 1783, when the former was forty-seven years old, they had reaped no profit. But for an act passed in 1775 to continue the rights of the patentees to the year 1800, in consideration of the great utility of the invention, the inventor must have been entirely deprived of the reward of his labour.

MR. BOULTON, OF BIRMINGHAM.

MR. BOULTON, the practical business-like partner of James Watt, though entitled himself to high rank as an inventor, never forgot to acknowledge the transcendent merits of his partner. The steam-engine was in his

mind the pride of the establishment over which he ruled. With a curious forgetfulness of his illustrious partner's origin, Boulton once said to Sir Walter Scott, in reply to some remark, "That is like the old saying—in every corner of the world you will find a Scot, a rat, and a Newcastle grindstone." "You ought," retorted Sir Walter, whose national feeling could not tolerate even a joke at the expense of his country, "to have added—and a *Brummagem button*." "Ah," replied Boulton, roused in his turn to a spirit of pride in his birth-place, "we make something better than buttons in Birmingham, Sir Walter;" and then added in a tone of dignity, "We make steam-engines." Boswell, the biographer of Dr. Johnson, has left us an interesting anecdote of Boulton. Boswell, who despised trade, and who regarded the writing of a preface to a commercial dictionary as a degradation of the talents of his master, nevertheless condescended to visit the Soho works in 1776, there to inspect the new machines of his fellow-countryman which had then just been completed. "I shall never forget," he says, "Mr. Boulton's expression to me when surveying the works: 'I sell here, sir, what all the world desires to have—POWER.' He had," adds Boswell, "about 700 people at work. I contemplated him as an iron chieftain, and he seemed to be a father of his tribe." Another interesting anecdote is told by Boswell in connection with this visit, interesting as illustrating the character of Boulton. "One of the men," Boswell tells us, "came to Boulton, complaining grievously of his landlord for having distrained his goods. 'Your landlord is in the right, Smith,' said Boulton; 'but I'll tell you what—find you a friend

"Who will lay down one-half of your rent, and I'll lay down the other, and you shall have your goods again."

Boulton devised some remarkable improvements in the machinery for coining, and attained to such rapidity and perfection of execution that he was employed by the Government to re-coin the whole copper money of the kingdom. Under his superintendence several foreign governments established his system. It is said that Boulton's senses were so acute that, while sitting in his office at Soho, he could detect, by a change in the sound of the motion, the least derangement in the machinery of his vast establishment.

IMPRACTICABLE INVENTORS.

BRUNEL, was continually tormented with impracticable and ignorant inventors, who solicited his attention for projects frequently of the most absurd kind. An Irish gentleman once submitted to him a design for a kind of hood for a carriage, the merit of which was that in fine weather it was to hang under the vehicle ready for use. "Impossible," exclaimed Brunel, after a moment's examination; "such a mass could never be stowed away in so small a space." "Do you think so?" said the Irish gentleman, not at all taken aback. "Ah! then we will soon get over that. The thing must be left at home in fine weather. Shan't want it then, you know." On another occasion his benevolent feeling was appealed to, to give attention to a new means of sweep-

ing chimneys, intended to obviate the necessity of the climbing boys, who were at that time used for this cruel employment. The plan was extremely simple: a broom was to be worked from above, as well as from below, and thus every nook, whichever way it turned, was to be easily swept out.

"Excellent," said the great engineer; "but you have not told me how the rope is to be got to the top."

"Nothing more simple," replied the sanguine inventor. "Of course, a boy will go up with it first."

Sometimes he was annoyed at finding that a kindly word, or a mere formal expression of politeness which he had used towards some of these tormentors, was construed into an approval of their schemes, which were forthwith announced as sanctioned by Brunel's approbation. This occurred in the case of a new machine, a "criopyrite" or fire-ram, invented by a Mr. Collier. This gentleman not only put forth his invention as sanctioned by Brunel, but referred inquirers to the agent of the latter, to testify to the soundness of his principle. Brunel was naturally indignant at this, and he replied, "Nothing is more preposterous than the account which has been published respecting this engine, which, it is added, consumes no more than one twentieth part of the fuel required for a steam engine of the like power. . . . Having been called on to witness its action and to give my aid in directing its power, I am enabled to state that the new engine, supposed to possess a power equal to twenty horses, has not yet to my knowledge moved without the external aid of two or three men."*

* Beauchamp's Memoir of Sir M. I. Brunel, 1862.

THE CORNISH MINERS AND THE ENGINE.

The first practical trial of Watt's engine took place in Cornwall. The sea had broken into some valuable copper mines in that county, the news of which reached his partner, who at once determined to put the invention to the test, and wrote to the miners informing them of its success, and of the means it afforded them of retrieving their disaster. The offer was sufficiently feasible to induce the Cornish miners to undertake a journey to Birmingham, on purpose to inspect the new engine. Its power to extricate them from the position of "drowned out," so terrible to the poor miners in that part of England, was probable, but it was costly—apparently an insuperable difficulty. Boulton, with the shrewd sense of a business man, then proposed to the miners to supply the capital himself, on an arrangement to be allowed a royalty of one-third of the value of the proved saving of coal (which is dear in Cornwall), as compared with the best of Newcomen's engines. The offer was accepted, and Watt himself being the only man capable of checking the operations of the machine of which he was the inventor, repaired to Cornwall to superintend the work. The superstitious Cornish people looked with a sort of vague terror upon this monster workman, who toiled night and day to deliver them from the terrible inundation. The noise had a sort of fascination for them, and, as Watt humorously said in a letter to his partner, "the people seemed to be no more taken with modest merit in an engine than in a man." Whether believers or not, the

velocity, violence, magnitude, and horrible noise, as Watt said of the engine, long continued to give unusual satisfaction. Having on one or two occasions trimmed the engine to end its strokes gently and make less noise, he found that the chief of the miners could not rest unless the machine worked more furiously, and the inventor was at length content to leave the matter to the engine-man. Even here, Watt's inventive faculties did not sleep. He devised a sort of meter to ascertain the saving effected, which marked the number of strokes, and being enclosed in a box could not be tampered with. The saving of coal was soon found to be nearly three-fourths of the quantity used with Newcomen's engine, or equal to a saving on the Chacewater engine of £7,200 a year. The success of Watt's invention was now proved, and orders for the new "fire engine" soon reached Soho.

THE DUKE AND THE INVENTOR.

THE propensity of military men, even of the highest genius, to cling to the ideas and notions in which they have been educated, was never better exemplified than by a correspondence which took place some years since between the late Duke of Wellington and Mr. Wright, the inventor of certain improvements in percussion caps. In 1820, percussion fire-arms had already almost superseded the old flint lock; but there were still some practical objections to the innovation which were readily taken advantage of by the old-fashioned shots of that

May. The disadvantage of the detonating powder then in use was that it quickly rusted the lock of the barrel, that it was affected by damp, and that the charcoal in the gunpowder occasioned the accumulation of dirt. In that year Mr. Wright, who was an ardent sportsman as well as an excellent chemist, was led to turn to practical account some experiments he had made with fulminating mercury as far back as the year 1805, soon after its discovery. He primed some caps with a preparation of this powerful detonator mixed with a solution of benzoin, as a protection against damp, and quickly found by experiment that the idea was valuable. After many trials he wrote to the Duke of Wellington pointing out the advantages of the new substance, as being free from damp, producing no rust, and being safer than the old preparation. In the same letter Mr. Wright suggested the application of the principle of percussion to ships' guns. The duke's reply was as follows:—"The Duke of Wellington presents his compliments to Mr. Wright, and has the honour to inform him, that the application of fire by percussion to naval ordnance has been considered by various committees of officers of the Navy, and of the Artillery, each of which has decided against it in every form. There are strong objections to the use of the copper cap, mentioned by Mr. Wright, which Mr. Wright has not taken into consideration."

The value of Mr. Wright's invention is now placed beyond doubt. In 1823, he published a full account of its process, and its superiority was soon afterwards generally admitted; but although subsequently adopted by Government it never received any other official recognition than is contained in the above letter. "I

"believe," says Dr. Wright, the son of the inventor. "The only business transaction which ever arose out of the invention was an expenditure of money in stopping some attempts to pirate and patent the discovery. The late Lord Dundonald, better known by the name of Cochrane, under which he gained his dashing naval victories, wrote, after reading the correspondence above alluded to:—

"SIR, — I thank you for your very interesting note, showing how the greatest characters may be led to acquiesce in wrong conclusions (from mental indolence) by trusting to ignorant, jealous, or interested officials. I shall preserve your valued communication as a testimonial to the fact, how difficult it is for merit to obtain a fair hearing.—I am, Sir, your obedient servant,
"DUNDONALD."

Dr. Wright remarks that there is a great difference between the style of these letters, but it must not be forgotten that the latter was written after the superiority of the percussion principle had been fully demonstrated.

THE EAR TRUMPET.

THE best kind of ear-trumpet, that useful invention to which the deaf owe so much, was devised by Dr. Arnott; the well-known scientific writer. Dr. Arnott was travelling by sea at night, when a window of the carriage being accidentally left open, caught him an inflammation of the throat, which, spreading upwards,

INVENTION AND DISCOVERY.

in permanently dulling the sense of hearing. Seeking upon a means of relieving himself in some measure from this troublesome affliction, he observed that persons whose hearing is good, will involuntarily hold the concave hand to the ear when straining to catch a distant sound. Finding, how useful this assistance was, and reflecting that many animals are endowed by nature with the power of turning the ears in the direction of any sound, he procured two small wooden cups, and joining them by a piece of wire, made an apparatus which could be adjusted to the ears pretty nearly as a pair of spectacles are fitted to the eyes. The result was satisfactory, and he discovered further that, when pressing these cups forward, by the hands against the backs of the ears, or keeping them so forward by a band crossing in front; the useful effect was increased. The well-known form of ear-trumpet, consisting of a long, flexible tube, with a small trumpet opening, which the afflicted person holds near the mouth of the speaker, is a more powerful conductor of sound; but all these contrivances are so inconvenient as to be frequently rejected. It is to Mr. Arnott's happy observation of the habits of men and animals that the deaf are indebted for an instrument which can be worn at all times without any more trouble or annoyance than is given by a pair of spectacles.

THE ORIGIN OF OUR CAST-IRON.

ABRAHAM DARBY AND THE SHEPHERD-BOY SECRETLY
CASTING THE IRON POT.

THE cast-iron which comes from the blast-furnace may, from its useful quality of fusibility, be immediately used, as every one knows, for manufacturing purposes by remelting it and pouring it into moulds of any required shape, this being the business of the ironfounder. Simple as this appears, the use of cast-iron is only of modern date compared with that of its purer rival. It may be obscurely traced to the fifteenth century, if not earlier, but the process of casting was beset with many mechanical difficulties, which were not thoroughly vanquished till about 1700, when Abraham Darby, an intelligent mechanic, who had brought some Dutch workmen to establish a brass-foundry at Bristol, conceived that cast-iron might be substituted for brass, and prevailed upon his workmen to make the experiment, but without success, until a happy incident occurred in connection with which Dr. Percy, in his great work on "Metallurgy," relates an interesting anecdote. About this period, a Welsh shepherd-boy, named John Thomas, succeeded in rescuing a flock of his master's sheep from a snow-drift, and later in the spring of the same year, during heavy rain and the melting of the snow, he swam a river to fetch home a herd of mountain cattle. These he collected and drove to the river, but the ford had now become a boiling torrent. He then placed the whole herd on the back of an ox, and brought them all to the whole herd in safety. As a reward for his services, he

Master presented him with four of the sheep which he had saved. He sold their wool in order to buy better clothing for himself, and afterwards disposed of the sheep, so that he might obtain money to travel to Bristol and seek his fortune. Afraid of being pressed for a soldier if found in Bristol out of place, as it was then the time of the Duke of Marlborough's wars, he requested his master to recommend him as an apprentice to a relative, who was one of the partners of the celebrated Abraham Darby of the Baptist Mills. The boy was accordingly sent into the brass-works until he should procure employment. As he was looking on during the trials of the Ditch workmen to cast iron, he said to Abraham Darby that he thought he saw how they had missed it. He begged to be allowed to try, and he and Abraham Darby remained alone in the workshop the same night for the purpose. Before morning they had cast an iron pot. The boy Thomas entered into an agreement to serve Abraham Darby and keep the secret. He was enticed by the offer of double wages to leave his master, but he continued nobly faithful, and afterwards showed his fidelity to his master's widow and children in their evil days. From 1709 to 1816 the family of Thomas were confidential and much valued agents to the descendants of Abraham Darby. For more than one hundred years after the night in which Thomas and his master made their successful experiment of producing an iron casting in a mould of fine sand, with its two wooden frames and its ~~same~~ the same process was practised and kept secret in Coalbrookdale with plugged keyholes and barred doors.

ARNOLD THE WATCHMAKER, AND HIS FRIEND
BRÉGUET.

THE notion that rivals in art are necessarily antagonistic in feeling, was never more completely falsified than in the case of the celebrated English watchmaker Arnold, and his friend M. Bréguet—both famous in the annals of horology for their useful inventions. A watch made by Bréguet fell into the hands of Arnold, who examined it with delight and astonishment. The perfection of the work, and the simplicity of the mechanism filled him with admiration; for as yet English watchmakers had not been accustomed to esteem the labours of their foreign brethren. Arnold knew nothing of the maker but the name on the watch, and where he also read the word "Paris;" but with an enthusiasm for his art he determined to set out for France immediately to make Bréguet's acquaintance. Arrived in Paris, he obtained an interview, and a strong friendship immediately arose between the two watchmakers. As a proof of his love and esteem for Arnold, Bréguet desired him to take his son to England, and instruct him in their art. Arnold was the inventor of those improvements known as the compensation pendulum, the compensation escapement and balance, and many other improvements in watches and other timekeepers, especially chronometers, for which he received several premiums from the Board of Longitude. He was also the author of several tracts, illustrative of the principles of his art. His wife was a remarkable person, and is said to have rendered great

assistance to her husband in his calculations. Their son, John Roger Arnold, was also a man of considerable ingenuity, and was the inventor, among other things, of an expansion balance for chronometers. In the Patent Museum, at South Kensington, is an interesting painting in oil, of a family group, representing Mr. Arnold and his wife seated, with their son standing between them, and listening to his father who is explaining the construction of a chronometer which he holds in his hand.

Bréguet was perhaps even more eminent as an inventor and practical watchmaker. Though not a Frenchman by birth, Bréguet had descended from one of the numerous French Protestant families who were compelled to fly from France, by the Edict of Nantes. He was born at Neuchâtel, in Switzerland, and began life as a simple workman; a fact which he never forgot; for it is said that when he became eminent, he was always a firm friend to young men of his own trade, and was enabled to assist many of them, from the warm interest which he took in their welfare. At school, Bréguet had appeared remarkable only for dullness; and there seems no doubt that he gave to his masters the impression that he was deficient in intellect. His father-in-law, who was a watchmaker, undertook to teach him that art, but Bréguet showed at first no interest in it. It was not until the father-in-law, in despair, had sent him to a watchmaker at Versailles, that he began to apply himself seriously to the study of the mechanism of watches. His apprenticeship ended, the master expressed himself well satisfied with the industry and perseverance of the young Swiss work-

man; but Bréguet only replied, "Master, I have favour to beg of you. You have praised my industry, but I know that, at least in the early part of my career here, I did not employ my time to the best of my ability. It will be a satisfaction to me to be allowed to work three months more under you, without wages." This request established a warm friendship between the master and the apprentice. The death of his father and mother about this time compelled Bréguet to labour for the support of his sister; but he nevertheless found time to attend the course of lectures on mathematics, delivered by the Abbé Marie, at the Collège de Mazarin, and to obtain a knowledge which he considered indispensable to the perfection of his art. When the French Revolution began, Bréguet had already founded the manufactory which afterwards produced so many admirable specimens of watchmaking. It is a melancholy fact that this first establishment was destroyed by the revolutionary mob, while Bréguet himself was compelled to fly from the country with his son, and to remain abroad two years, during which time he was indebted to the assistance of friends for the means of continuing the exercise of his profession. Happily, better days arrived; the revolution at an end, Bréguet returned to his adopted country, and opened a new manufactory, where he grew in reputation, and became more and more prosperous, until his death in 1823. An eloquent French writer, in commenting on Bréguet's labours, observes, "Bréguet brought all parts of his art to perfection. Nothing can be more delicate, nor more ingenious, than his detached escapement. He invented also an escapement, called Natural, in which

No oil is necessary, and in the mechanism of which there is no spring. Another still better and finer invention of Bréguet is that of the duplex escapement, which also dispenses with the necessity for oil. Portable marine watches or chronometers may without injury experience any change of position, except that caused by the rolling of a vessel. Bréguet conceived the idea of enclosing the whole mechanism of the escapement and the spring in a cylinder, which performs a complete revolution every two minutes.

"Bréguet also discovered a method of preserving the regularity of his chronometers, even in case of their being struck or experiencing a fall to the ground. Such is the effect of his *parachute*. An English observer, General Brisbane, possessing one of these chronometers, subjected it to great trials by constantly wearing it on horseback; and during several long voyages, in sixteen months the greatest variation was only a second and a half, that is to say, the 57-600th part of a diurnal revolution.

"At the time when Bréguet obtained this great result, adds M. Charles Dupin, the writer referred to, the English parliament, with British generosity, had offered a reward of two hundred and fifty thousand francs to the artist who would make a chronometer for ships, the daily variation of which should not exceed two seconds. No one had gained this prize when Bréguet exceeded this limit, as above stated."

THE INVENTOR AND THE PIRATES.

THE chief annoyance to which Watt was subjected after his steam-engine had begun to attract attention arose from the attempt of dishonest persons to pirate his invention, and thus to rob him of the fruit of his lifetime of toil and trouble. Watt had found that the best way of obtaining continuous motion was by the crank. "Not," Watt says, "in its simple form an original invention." And he adds modestly, "the true inventor of the crank rotative motion was the man, who unfortunately has not been deified, who first contrived the common foot lathe. The applying it to the engine was merely taking a knife to cut cheese which had been made to cut bread."

It happened that, while Watt and his partner Boulton were constructing models for their crank at Soho, a number of their workmen were, one Saturday evening drinking their ale at a poor public-house called the "Waggon and Horses," in the village of Handsworth, near by. The nature of the models preparing at the works was a secret which the men were expected not to divulge; but as the drink passed round, they became talkative, and one of them named Cartwright—a man who was afterwards hanged—began to talk boastfully of his master's design; probably urged on by a stranger among the company, who, though in a workman's dress, might easily have been detected as belonging to a superior class. The man sat in a corner, and as soon as the workmen began to talk freely, became silent and atten-

give, not only to every word of the conversation, but to a rough sketch which Watt's workman, finding a piece of chalk at hand, proceeded to make on the table. No sooner had they gone than the assumed workman started for Birmingham, and took post horses for London. A few days later, Watt's crank motion was registered in the patent office by a man named Wasborough. Watt was extremely angry at the trick which had been played him, and averred that Wasborough had stolen the invention from him by the most infamous means; but his inventive genius helped him to defeat the fraud. In a few weeks he devised his well-known "sun and planet motion." This was unfortunately not the only occasion on which the great inventor had suffered from the roguery of plagiarists. When a young man, in his little mathematical instrument shop in Glasgow, a prosperous London maker had impudently appropriated his drawing machine. Another plagiarist had coolly appropriated his micrometer. His crank had now been lost to him through the idle talking of one of his own men. His property in the condensing engine itself, which had cost him twenty years of anxiety and labour, was threatened. The Cornish miners, whose industry had been so enormously benefited by it, and of whom Watt claimed only one-third of the money that he undertook to save them, made artful excuses for evading the fulfilment of their engagement. "We have been so beset with plagiaries," he wrote to a friend, "that, if I had not a very good memory of my doing it, their impudent assertions would lead me to doubt whether I was the author of any improvement on the steam-engine, and the ill-will of those we have most essentially served,

whether such improvements have not been highly prejudicial to the commonwealth!"

Though Watt and his partner succeeded in their lawsuits, they were nearly ruined by the expense of litigation. During the last four years of their patent alone, these expenses amounted to between five and six thousand pounds. After one of these vexatious trials, "I remained," says Watt, "nearly as much depressed as if we had lost it. The stimulus to action was gone, and but for the attentions of my friends I ran some risk of falling into stupidity." Even after he had retired with a very moderate fortune, that he might enjoy the quiet for which alone he was fitted, he spoke of himself as incapable of any further efforts, ascribing his prostration to the vexation he had endured for many years from this harassing lawsuit.

A QUICK DECISION.

THE elder Brunel was habitually absent in society; but no man was more remarkable for presence of mind in an emergency. Numerous instances are recorded of this latter quality, but none more striking than that of his adventure while in the act of inspecting the Birmingham Railway. Suddenly in a confined part of the road a train was seen approaching from either end of the line, and at a speed which it was difficult to calculate. The spectators were horrified; there was not an instant to be lost; but an instant sufficed to the expe-

experienced engineer to determine the safest course under the circumstances. Without attempting to cross the road, which would have been almost certain destruction, he at once took his position exactly midway between the up and down lines, and drawing the skirts of his coat close around him, allowed the two trains to sweep past him; when, to the great relief of those who witnessed the exciting scene, he was found standing untouched upon the road. Without the engineer's experience which enabled him to form so rapid a decision, there can be no doubt that he must have perished.

BLUNDERS OF THE TELEGRAPHERS.

BEFORE the telegraph operators became so expert as at present, ludicrous blunders were of frequent occurrence from the necessary ambiguity in transmitting one letter at a time. An American manager of a telegraph company gives an instance as of recent occurrence upon the line between Boston and New York. A gentleman sent a despatch requesting parties in New York to forward sample forks by express. When the message was delivered it read thus, Forward sample for K. S.

The parties who received it replied by asking what samples K. S. wanted?

Of course the gentleman came to the office and complained that the despatch had been transmitted incorrectly, and the operator promised to repeat it. Accord-

ingly he telegraphed the New York operator that the despatch should have read, "Forward sample forks." The New York operator, having read it wrong in the first instance, could not decipher it differently now. He replied that he did read it, "Sample for K. S., and so delivered it.

"But," returned the Boston operator, "I did not say for K. S. but f-o-r-k-s!"

"What a stupid that fellow is in Boston!" exclaimed the New York operator. "He says he didn't say for K. S., but for K. S."

The Boston operator tried for an hour to make the New York operator read it forks, but not succeeding, he wrote the despatch upon a slip of paper, and forwarded it by mail; and it remained a standing joke upon the line for many months afterwards.

THE LAST DAYS OF JAMES WATT



WHEN Watt was in his seventy-fifth year, and long after he had retired from business, he was consulted as to a means of conveying water from a peninsula across the river Clyde to engines at Dalmarnock, a problem of great difficulty, and which baffled the scientific skill of any other engineers that the Water Company had been able to discover. Watt, who was above all things distressed by the fear of his mental faculties deserting him in old age, and who had mastered the German language, when an old man to test his memory, was not sorry for

an opportunity of once more taxing his inventive faculties. The plan which he suggested was extremely ingenious and altogether novel. The chief difficulty was to adapt the pipes to the irregular bed of the river. The peculiar formation of the tail of a lobster at once suggested to the wonderful old man the solution of the problem. Taking this for his model, he forwarded a plan of a tube articulated in this peculiar manner; a sketch was executed, the pipes laid down, and the great inventor had the satisfaction of hearing that his idea had proved perfectly successful. Among other things devised by Watt in the leisure moments of his grander schemes were an arithmetical machine, a spiral oar for the propulsion of ships, a steam carriage for use on common roads, a machine for copying letters, an instrument for measuring the specific gravity of fluids, a regulator lamp, a plan for warming buildings by steam, and a machine for drying linen. To economize labour, or save annoyance to the book-keeper in his country house, the sailor in his ship, the traveller on the highway, the clerk at his desk, the chemist in his laboratory, the student by his lamp, or even the poor laundress in her daily work were equally the objects of his busy mind.

"I remember," says a lady who knew him well, "a celebrated Swedish artist having been instructed by him that rats' whiskers make the most pliant painting-brushes; ladies would appeal to him on the best means of devising grates, curing smoking chimneys, warming their houses, and obtaining fast colours. I can speak from experience of his teaching me how to make a dulcimer and improve a Jew's-harp." The same lady has given us an interesting sketch of Watt's personal

appearance. "He was," she says, "one of the most complete specimens of the melancholic temperament. His head was generally bent forward, or leaning on his hand in meditation, his shoulders stooping and his chest falling in, his limbs lank and unmuscular, and his complexion sallow. His utterance was slow and unimpassioned, deep and low in tone, with a broad Scottish accent; his manners gentle, modest, and unassuming. In a company where he was not known, unless spoken to, he might have tranquilly passed the whole time in pursuing his own meditations. When he entered a room, men of letters, men of science, nay, military men, artists, ladies, even little children thronged around him.*

The last of all his inventions was his machine for taking reduced copies of busts and statues. At Steathfield, in Staffordshire, whither he had retired, he had a small workshop adjoining his bedroom. Here he spent usually the greater part of the day, attired in a woollen suit, a leather apron, and a rustic hat—the same which he had worn when a humble workman forty years before. He succeeded so well with his machines as to produce specimens of his sculpture chiefly in the shape of busts, which he distributed among his friends, describing them as "the productions of a young artist just entering his eighty-third year." It was upon this machine that Watt was engaged, working contentedly at his "likeness lathe," as he termed it, when death put an end to his busy career, and the unfinished machine was left, standing a touching memorial of his departure.

* Autobiography of Mrs. Schumelpenninck.

THE SECRET OF MAKING DOLLS' EYES.

How a Birmingham manufacturer learnt the secret of making dolls' eyes, and how Birmingham came to be extensively engaged in making these apparently trifling but really important little articles was amusingly explained by Mr. Ostler, of that city, some years ago before a committee of the House of Commons:—"A respectable looking man in the city," says Mr. Ostler, "asked me if I could supply him with dolls' eyes, and I was foolish enough to feel half offended; I thought it derogatory to my dignity, as a manufacturer, to make dolls' eyes. He took me into a room quite as wide, and, perhaps, twice the length of this committee room, and we had just room to walk between stacks, from the floor to the ceiling, of parts of dolls. He said, 'These are only the legs and arms; the trunks are below.' But I saw enough to convince me that he wanted me to make a great many eyes, and as the article appeared quite in my own line of business, I said I would take an order by way of experiment; and he showed me several specimens. I copied the order. He ordered various quantities, and of various sizes and qualities. On returning to my hotel, I found that the order amounted to upwards of £500. I went into the country and endeavoured to make them; I had some of the most ingenious glass-toy makers in the kingdom in my service; but when I showed it to them, they shook their heads, and said they had often seen the article before, but could not make it. I engaged them by

presents to use their best exertions; but after trying and wasting a great deal of time for three or four weeks, I was obliged to relinquish the attempt. Soon afterwards I engaged in another branch of business (chandelier furniture), and took no more notice of it. About eighteen months ago I resumed the trinket trade, and then determined to think of the dolls' eyes; and about eight months since I accidentally met with a poor fellow who had impoverished himself by drinking, and who was dying in a consumption, in a state of great want. I showed him ten sovereigns, and he said he would instruct me in the process. He was in such a state that he could not bear the effluvia of his own lamp; but though I was conversant with the manual part of the business, and it related to things I was daily in the habit of seeing, I felt I could do nothing from his description (I mention this to show how difficult it is to convey, by description, the mode of working). He took me into his garret, where the poor fellow had economized to such a degree, that he actually used the entrails and fat of poultry from Leadenhall market to save oil (the price of the article having been lately so much reduced by competition at home). In an instant, before I had seen him make three, I felt competent to make a gross."

Mr. Ostler afterwards became a large manufacturer of these articles.

THE "SPINNING JENNY" AND THE "MULE."

JAMES HARGREAVES, who has been called "one of the martyrs of scientific industry," invented the spinning jenny in 1767, a most original device, differing widely from the water frame of Arkwright. It was while working as a poor weaver in a factory near Blackburn, that he first conceived his idea of making a machine which would spin more threads than one at a time. But no sooner had he completed it than the persecution of his fellow-workmen compelled him to leave his native place. Fortunately, some of his jennies, which he had sold, escaped the fury of the mob; the importance of the invention was demonstrated, and its use rapidly extended. It was on one of these machines, only two years after their invention, that Samuel Crompton, then a youth of sixteen, spun with eight spindles the yarn which he afterwards wove into quilting. The history of Crompton's invention is still more romantic. Strongly interested in the beautiful devices for saving labour, which he had daily under his eye, the young man's mind turned constantly to the idea of still further improvements; and it was in 1774, when twenty-one years of age, that he made the first step towards putting these notions in practice by constructing a new spinning machine, which was finally known as the "mule," it being a kind of cross between Arkwright's machine and Hargreaves jenny. It was at first called the "muslin wheel," and the "Hall i' th' Wood wheel," from the house in which Crompton lived, and in which he in-

vented it. Never did a poor cotton-spinner inhabit a more romantic dwelling. It was a noble old mansion, with many gables and twisted chimneys, and ornamental woodwork let into the external plaster. This rather dilapidated house had been the residence of an old wealthy Lancashire family, and when Crompton lived there in his childhood, was surrounded by ancient oaks standing in a beautiful landscape. In a corner of this poetical home Crompton lived. It cost him five years to perfect his idea of the mule, working in secret, and without sympathy or aid, and generally in the night time when his day's labour at weaving was done. This midnight work, the strange sounds occasionally heard in the large upper room of the house, and the lights seen glimmering through the old lattice-framed casements, far into the night, spread the rumour that the old mansion was haunted; but when it became known that the cause of all this was the young weaver, who was working with bits of wood and iron, they pointed at Crompton as he went along as the "conjurer." His machine exhausted every penny he could spare from his scanty earnings; and to help him in getting tools he had to hire himself, with a violin, on which he taught himself to play tolerably well, to perform in the orchestra at the Bolton theatre, where he received eighteen pence a night.

The old trouble of inventors—machinery riots—soon came to teach him the danger of attempting to benefit others by ingenious devices for shortening labour. The cry everywhere was "Men, not machines!" and the terror of this movement reached the poor weaver in his lonely dwelling. He was compelled to take his

machine to pieces and hide it in a garret near the old hall. It was not until some time after this storm had blown over that he ventured to bring out the pieces, and fit them together again, but from that time its success was established, and he began to reap the profits of his ingenuity. Misfortune, however, in some shape, always pursued him. Every one succeeded better with Crompton's mule than Crompton himself. Robert Peel made mules in his own factory, and entered into competition with the inventor; but it is stated he offered Crompton a place of trust in his establishment, and even a partnership, which the pride and independence of the latter led him to refuse. Mr. Dale of Lanark, turned the mules with water, and increased their power greatly. Arkwright used them in his manufactories, and doubled his wealth, leaving a colossal fortune to his children. But Crompton lived at Oldham in comparative poverty; yet the country owed him much.

In 1812, when Government assigned him five thousand pounds, as a national reward, the duty paid by cotton, imported to be spun on his machines, came to more than one thousand pounds a working day.

THE ORIGINAL SEWING MACHINE.

In the year 1841, Elias Howe, a native of Cambridge Port, Massachusetts, first conceived the idea of constructing a really practical sewing machine. I know

of no higher example of patient industry and perseverance, indeed, I may say, of devotedness to science (says Mr. Alexander, to whose interesting paper recently read before the Society of Arts we are indebted for these particulars), than that displayed by Howe in his early career. A young mechanic, only twenty-two years of age, hardly capable of supporting himself and those most dear to him on his scant earnings, he laboured manfully in a little garret in his native town at his self-imposed task during the few hours that were spared to him after the ordinary labours of the day were ended. He became enthusiastic, and although, as he says, he could not devote his attention to the subject during his working hours, he thought upon it when he could, both day and night. It grew upon him till he felt impelled to yield his whole time to it, and being promised assistance by a friend, he devoted himself exclusively to the construction and practical completion of his machine. The result was that in 1845 he perfected his first sewing machine, and in order to test its practical success, he sewed with it all the principal seams in two suits of clothes. On the 10th of September, 1846, he obtained his patent.

In Howe's original machine, a curved needle attached to the end of a vibrating lever was combined with a reciprocating shuttle for producing the lock-stitch. The needle had an eye near its point, and a groove formed along the upper and under sides, to allow of the thread lying therein, and so passing more easily through the cloth. The cloth was attached to pins on the edge of a thin steel rib called a "baster plate," probably from the fact of its serving the purpose

of a basting thread in holding the two thicknesses of material together whilst being stitched. This plate formed a portion of the feed mechanism for propelling the cloth; it was carried along step by step by the teeth of a small pinion which geared into holes made in the baster plate, an intermittent rotatory motion being imparted to the pinion by self-acting mechanism working in concert with the needle and shuttle. This feed motion was found to be defective in many respects, and has since been entirely abolished in all sewing machines. The cloth was held in a vertical position against the side of the shuttle race, by a spring presser-plate, at the part where the needle entered. The shuttle was driven to and fro in its race or groove by two strikers, carried on the ends of vibrating arms worked alternately by "cams." The most important features embodied in this machine were the adaptation of contrivances for giving the requisite tension to the needle and shuttle-threads, for taking up the slack formed on the needle thread when the needle enters the cloth, for tightening and drawing up the stitch, and for supporting the cloth against the thrust and withdrawal of the needle. Shortly after obtaining his patent in America, Howe sent over a machine to this country, and disposed of his invention to Mr. William Thomas for a trifling amount.

Shortly afterwards, Mr. Thomas obtained a patent for the machine in England, soon after which Howe himself arrived here to assist him in adapting the machine to the peculiar kind of work required, namely, stay-making. Howe does not appear to have prospered here, for in the spring of 1849, indebted to a friend for

a steerage passage home, he returned to America, poorer if possible than when he left. He found his wife on a bed of sickness and in a state of utter destitution. Ten days after his arrival she died. During his absence in England his patent had been extensively infringed, but in 1850 he commenced legal proceedings, and succeeded in every case in establishing the validity of his patent.

In the course of these proceedings a prior claim to the invention of the sewing machine was set up by Walter Hunt, who was said to have constructed, exhibited, and sold, in 1834 and 1835, shuttle or lock-stitch sewing machines, similar in all essential particulars to Howe's. There is no doubt that Hunt had tried his hand at a lock-stitch sewing machine, and was the inventor of the shuttle or lock-stitch, but it was never satisfactorily proved that such machines were so far perfected as to render them more than abortive experiments. The turning point in Howe's career had now arrived, and fortune soon began to smile upon him. In 1853 he granted his first licence, and in 1855 was enabled to regain possession of the whole of his patent, which at one period he had entirely disposed of, in order to meet the pressing demands that were made upon him. His patent rights are now finally acknowledged, and his patent being prolonged for a term of seven years, he receives a royalty from every sewing machine established in America, from which he is said to derive an income of upwards of fifty thousand pounds per annum.

THE SAFETY LAMP AND ITS INVENTOR.

THE year 1815 was rendered memorable by the invention of the safety lamp. The process by which its inventor advanced to the discovery is curious and instructive. First, he ascertained, by full and exact inquiries, all the facts of the case as known to the miners. Secondly, he proceeded to learn more fully the properties of the agent which he was to attempt to control. What is this fire-damp? He analyzed it and found it to be, as other chemists had said, a variety of carburetted hydrogen gas. The next question was; what will kindle it? A red-hot iron will not; a burning coal will not. It therefore requires a higher degree of heat to inflame it than most other explosive gaseous mixtures. And here an important inference met him—that if the gas, when on fire, were cooled, it would be extinguished. Again, carburetted hydrogen, by burning, produces carbonic acid, and the atmospheric air with which it is mixed in the explosive compound, produces nitrogen; and each of these products, added to the explosive mixture, impairs, or even destroys its power of exploding; and, therefore, since these rise from a burning lamp, they would of themselves prevent the communication of the flame through the open chimney of the lamp. His next inquiry was—Under what circumstances does the fire-damp burn with explosion? The general reply is, when mixed with air; but experimenters were instituted to ascertain the effect of different proportions of air. One part of fire-damp,

and any portion of air less than four parts, burnt without explosion; seven or eight of air to one of the other, constituted the most highly explosive mixture. In fifteen of air to one of fire-lamp a lamp burnt without explosion, and with the flame greatly enlarged. Davy now came to the question, Through what channels (if there be any) between two separate portions of these explosive mixtures will the flame, when applied to one of them, refuse to pass the other? Will it pass through a tube? This brought him to the grand discovery; for it appeared, that the flame of the most explosive mixture would not pass through a small tube; that the communication was more easily prevented, in proportion as the tube was of a better conducting substance, and, therefore, operated by cooling the flame below the point of kindling. The problem, therefore, was only how to surround a lamp with a transparent envelope, communicating with the surrounding air by metallic tubes, in order that the air might enter freely to feed the lamp, while the flame would not be communicated to the surrounding atmosphere, in the most explosive state in which it ever could exist in a coal mine. Subsequent experiments proved, that in case the diameters of the tubes were very small, their lengths might be diminished to mere apertures; and hence it was only necessary to surround the lamp with wire gauze, and the air would enter freely to supply the lamp, while the flame could not pass through the apertures of the gauze.

Some friends having spoken of Davy in the highest terms to Count Rumford, the latter was induced to enter into a negotiation, for the purpose of engaging the young chemist as a lecturer at the Royal Institution.

This occurred in 1801, and in February, as appears by the following extract from the minute-book, he was engaged:—"Monday, Feb. 16, 1801. Resolved, that Mr. Humphry Davy be engaged in the service of the Royal Institution, in the capacities of assistant lecturer in chemistry, director of the laboratory, and assistant editor of the journals of the institution; and that he be allowed to occupy a room in the house, and be furnished with coals and candles, and that he be paid a salary of one hundred guineas per annum."

From that period, his fame and popularity constantly increased. His brother tells us, that he was in the habit of receiving letters of the most laudatory nature, many written by females, who regarded him with great admiration. There is an entertaining anecdote illustrative of his popularity, even among the more humble classes. He was passing through the streets one fine night, when he observed a man showing the moon through a telescope. He stopped to look at the earth's satellite, and tendered a penny to the exhibitor. But the latter, on learning that his customer was no less a person than the great Davy, exclaimed with an important air, that "he could not think of taking money from a brother philosopher." Correspondents, addressed him from all parts. A letter sent to him from Italy reached him safely, though it only bore the mysterious superscription:—

SIROMFREDEVI,
LONDRA.

Davy was no less remarkable for his 'courtesy to strangers than for his modesty of demeanour. Although he was attacked at various times by Gay Lussac and Thénard, by Murray, Berzelius, and other rivals, he appears never really to have lost his temper. When he had occasion to allude to his own discoveries, he always spoke of them as things which he had had the good fortune to discover. When circumstances required the application of a new name, as that of chlorine, his account of the matter was, "after consulting several eminent men I have ventured to propose this name."

INVENTION OF REVOLVING FIRE-ARMS.

It is not much more than eighty years ago since Benjamin Franklin gravely recommended his fellow countrymen, then at war with King George's troops, to return to the use of the very weapons which were employed by Ishmael the son of Abraham. Bows and arrows, he said, were very good arms, and not wisely laid aside: first, because a man may shoot as truly with a bow as with a common musket; secondly, because he can discharge four arrows in the time of charging and discharging one bullet; thirdly, because his object is not obscured from his view by the smoke of his own comrades; fourthly, because a flight of arrows seen coming upon them terrifies, and disturbs the enemy's

attention to his business; fifthly, because an arrow sticking in any part of a man, disables him until it is extracted; and sixthly, because bows and arrows are more easily provided everywhere than muskets and ammunition. Indeed, the struggle between bows and guns was long, and at one time seemed doubtful. Thirty thousand Frenchmen fell at Crecy, mostly pierced by the arrows and bolts of the English and of their Genoese auxiliaries; and old French chroniclers attest the terror and confusion which the English archers always produced in the enemy's ranks.

It is only within a few years past that portable fire-arms have ceased to be so clumsy and inefficient as almost to justify Franklin's preference for the old English bow. It has been said that each soldier in our wars carrying the old musket fired away his own weight in lead for every man of the enemy whom he wounded; and in the desultory warfare at Cape Colony, it was calculated that every wounded Caffre represented an expenditure of three thousand two hundred balls. So little was the musket dreaded by these savages that it was long a favourite sport with them to provoke sentries or small bodies of troops to fire upon them, and then rushing forward, to wrench their muskets from their hands; and so obvious were these tactics that the Indians in Texas, without knowing anything of the Caffres, treated their white enemies in the same way. It was in this country that the necessity for improved fire-arms was perhaps more strongly felt than in any other part of the world.

The prairie tribes of Texas ride with boldness and wonderful skill. They are so dexterous in discharging

arrows from the bow, that a single Indian, galloping at full speed, is capable of keeping an arrow constantly in the air between himself and his enemy. The American borderers have become hardy, self-reliant, and super-abundantly warlike, from the necessity of maintaining their footing against such undaunted and skilful foes. Their Virginia bear-rifles and double-barrel rifles were an improvement; but the first had no advantage except its long range and spinning bullet; and the latter, although valuable for giving two chances instead of one, was very heavy, difficult to aim with, and, when once discharged, took as long to reload as two muskets. They were taught early that their great countryman's preference for the oldest weapon in the world, over the latest improved fire-arms of his days, was not so paradoxical as it seemed. They must many a time have envied the Indian his rapid and continuous discharge, and wished for a gun that would fire many balls without reloading.

Such weapons had been attempted long before in Europe, and abandoned as impracticable. There are, in the Armory of the Tower of London several guns of Indian make and of very beautiful workmanship, which are known to be as old as the fifteenth century. These guns are in principle precisely the same as the guns and pistols now known as revolvers, or repeating fire-arms; but they have serious defects. They are liable to ignite all the charges at once, and seem to have been abandoned for practical warfare as dangerous or useless. No treatises spoke of them, though there were similar specimens of British and French manufacture in the United Service Museum, and at the Rotunda at Woolwich; at

Warwick Castle, and at the Musée d'Artillerie, and the Hôtel Cluny in Paris. Even when Elisha Collier, an American gunsmith, in the year 1818, discovered the same principle, he fell into the very errors which earlier gunmakers had already remedied. Another American gunsmith in the following year patented a revolver, which was also found to be impracticable.

Colonel Colt is believed to have been the first inventor of a really available repeating pistol. Ignorant, as he declares himself to have been, of all previous attempts of the kind, and having an imperfect knowledge of mechanics, he had thought as early as the year 1829 of the possibility of making a pistol that might be fired many times without reloading. Living, he says, in a country of most extensive frontier, still inhabited by aborigines, and knowing the insulated position of the enterprising pioneer, and his dependence sometimes alone on his personal ability to protect himself and his family, he had often meditated upon the inefficiency of the ordinary double-barrelled gun and pistol; both involving a loss of time in reloading, which was frequently fatal in the peculiar character of Indian warfare. When a youth, indeed, returning from a voyage to India, he had amused himself on board the vessel in constructing a model of his idea in wood, burning out the bores with hot iron. His first device was that bundle of barrels, well known in the windows of the London gunsmiths, and which is merely a multiplied double barrel. But, in 1835—about the time when Her Majesty's Board of Ordnance were beginning to hear of percussion caps, invented thirty years previously—Colonel Colt patented in the United States a pistol on

the principle of a rotating cylinder breech, and a single barrel—a far more simple and beautiful invention, which under several modifications is now in use.

INTRODUCTION OF GUTTA-PERCHA.

THE success of the submarine telegraph, which was first demonstrated in 1851, when the deep sea cable was laid down in the English Channel between Dover and Calais, entirely depended upon a single point. No submarine cable could be used for telegraphic purposes until its insulation was rendered perfect. Only one material was known to possess this insulating property, as being at the same time indestructible by water, and a bad conductor of electricity. This substance was gutta-percha, now so well known to every one in an infinite variety of forms, but which only twenty years ago had scarcely been heard of. It was in 1842 that Dr. Montgomery, an assistant surgeon to the Residency at Singapore, sauntered out one day in the neighbourhood of that city. His attention was attracted by a native woodcutter at his work, and the doctor was struck by the appearance of the hatchet which the man was using. It seemed to be both strong and flexible, and did not resemble any substance which the doctor had ever seen employed for that purpose. On questioning the man, he learnt no more than that the mysterious material could be made into any form by dipping it into

boiling water till it was heated through, when it became plastic as clay, regaining, however, when cold, its original hardness and rigidity. Struck by these facts, Dr. Montgomery inquired further, and soon discovered what he had suspected, that gutta-percha, like india-rubber, was a gummy substance which oozed out from between the bark and the wood of certain forest-trees, and that it could be had in great abundance. The great utility of such a substance in the arts at once presented itself to his mind. He obtained specimens in various stages of preparation, and sent them to the Society of Arts in London. The Society subsequently conferred a gold medal upon Dr. Montgomery. But the substance had already been seen in Europe. Even as early as the time of Charles I., the well-known botanist, Tradescant, had brought hither a specimen of this curious product, under the name of Mazer wood, and it had subsequently been often brought to Europe under the general name of india-rubber, in the form of elastic whips, sticks, etc.; but had never attracted much attention. It was in the year 1844 that two hundred-weight of this new article of commerce was shipped as an experiment from Singapore. The exportation rapidly increased. In the first four years and a half of the trade, 21,508 piculs of gutta-percha, each picul weighing about 133 pounds, were shipped at Singapore, the whole of which were sent to England, with the exception of 15 piculs to the Mauritius, 470 to the Continent of Europe, and 922 to the United States.

But this rapid growth of the new trade conveys only a faint idea of the commotion it created among the native inhabitants of the Indian Archipelago.

The jungles of the Johore were the scenes of the earliest gatherings, and they were soon ransacked in every direction by parties of Malays and Chinese, while the indigenous population gave themselves up to the search with a unanimity and zeal only to be equalled by that which made railway jobbers of every man, woman, and child in England about the same time. The knowledge of the article stirring the avidity of gatherers, gradually spread from Singapore northward as far as Penang, southward along the east coast of Sumatra to Java, eastward to Borneo, where it was found at Brunei, Sarawak, and Pontianak on the west coast, at Ketil and Passer on the east.

A boat made of the new substance was constructed for the expedition fitted out by Lady Franklin some years ago, to search for her brave husband and his comrades in the arctic regions. As was anticipated, it proved to be remarkably adapted for use in the ice. The gutta-percha boat belonging to the "Prince Albert" was under the charge of Mr. Snow, who has given an interesting account of the services which it rendered to the expedition. Whilst the other boats constructed of wood suffered much by the cutting of the young ice, the gutta-percha boat was found to be not in the least damaged, and returned to England in almost as good a condition as when it left, although it had performed all the rough work of the voyage. Mr. Snow adds:—

"The severest trial it endured, and endured successfully, was on both my visits to Whale Point, Port Leopold. As those unaccustomed to the nature of the ice that was there met with, it will be impossible fully to

conceive the position a boat was placed in. The mere transit to and fro, among loose masses of ice, with the sea in a state of quiescence, would have been quite enough to have proved the value of gutta-percha boats; but when, as in the present case, those masses were all in restless agitation, with a sea rolling in upon an opposing current, it might have been well excused—and without deteriorating from the previously attested goodness of the article—if it had not been able to have resisted the severe shocks it received. . . . Sliding through and over the ice, sometimes lifted completely out of the water by the sudden contact of a restless floe, and at others thrown sideways upon an adjoining craggy piece—I think it would have been next to impossible for any other kind of boat to have been otherwise than crushed or stove in on the instant.”

It was in commemoration of these facts, that the happy explorers gave the name of “Gutta-Percha Inlet” to the chief scene of the gallant little boat's adventures.

JENNER, AND THE DISCOVERY OF VACCINATION.

MORE than fifty years before Jenner commenced the inquiries which led to his great discovery, an immense benefit had been conferred on mankind by the introduction into England of the system of inoculation, or ingrafting, as it was then called, which consisted in communicating the small-pox itself to the patient almost in the same way as the cow-pox is communicated under Jenner's system. It is difficult now to imagine the ravages committed by this fearful disease before these great discoveries. In Russia alone the small-pox is said to have swept away two millions of lives in a single year. In the family of an English nobleman, Lord Petre, during the last century, eighteen individuals were found to have died of this complaint during twenty-seven years. So fatal was the disease, that it was found at the Small-pox Hospital, where the most careful treatment was resorted to, that one in seven, at least of the patients died under it, while a large proportion were in some way permanently afflicted by its destructive influence. In the London Asylum for the Indigent Blind, it was stated that three-fourths of the objects there relieved had lost their sight through small-pox.

Inoculation had long been resorted to as a preventive in Eastern countries, and was introduced here by the celebrated Lady Mary Wortley Montagu, in 1721, after her return from Turkey, whither she had accompanied her husband, the ambassador from Great Britain. It is said that a similar practice had prevailed in some

counties of England, under the singular name of "buying the small-pox;" but it was at least considered so strange in London, that even after this remarkable lady had boldly tried it upon her two children, none but criminals, induced by an offer of pardon, could at first be found to submit to it. It was in August, 1721, that Dr. Maitland, in the presence of several eminent physicians and surgeons, performed this experiment upon three women and three men, all of whom had been condemned to death. The fact that these persons were found to receive the disease in a comparatively mild form—all of them recovering in a short time—led to further experiments; and in the following year, the Princess of Wales, afterwards Queen Caroline, wife of George II., determined that her two children, the Princesses Amelia and Caroline, should undergo the operation. All these trials having proved remarkably successful, the practice began to extend; but a number of cases soon afterwards terminating fatally, it received a serious check, and never became general.

According to Jenner's own account, it was some time before the year 1776, and therefore probably while he was practising as a surgeon and apothecary in his native village of Berkeley, in Gloucestershire, that he first began his inquiries into the nature of cow-pox; but long before this his attention had been called to the subject of the supposed effect of cow-pox in giving immunity from the more dangerous disease. Jenner, who was the son of the Vicar of Berkeley, had been apprenticed to a surgeon named Ludlow, at Sudbury, a little village near Bristol; and it was here that he was one day called upon to give medical advice to a young country woman.

who doubtless filled the place of dairymaid at a farm in the neighbourhood. Having casually mentioned in her presence the subject of the small-pox, the young woman immediately remarked, "I can't take that disease, for I have had cow-pox." Further inquiry showed that this was a popular notion in that part of the country; and although it was regarded by the medical profession as only a vulgar belief, it was too suggestive to be lost sight of by the surgeon's apprentice. He well knew that an eruption, when showing itself on the hands of dairymaids who had milked cows similarly disordered, had attracted attention forty or fifty years before; and when he had settled down to practice as a country apothecary, he noticed that among those whom he was called on to inoculate in farmhouses, many resisted every effort to give them the small-pox. These patients, he found, had all been accustomed to milk cows, and had undergone the disease called cow-pox. His path, however, was still beset with difficulties. Few sympathized with him in an inquiry into what appeared to be merely an idle notion of the ignorant; and most persons regarded the idea of communicating to a human being a disease peculiar to a brute, as revolting, or even impious. Even the great John Hunter, in whose house Jenner, when a young man, had resided two years, paid little attention to the suggestion; and at a country medical club, of which Jenner was a member, the members denounced the whole topic as a nuisance, and sportively threatened to expel the orator, if he continued to harass them with his importunate discourse upon his favourite notion. These obstacles, however, would have been trifling, if the subject itself had not been

complex and intricate. He found, to his bitter disappointment, that numbers of those who seemed to have undergone the cow-pox, nevertheless, on inoculation under the old system introduced by Lady Mary Wortley Montagu, suffered from small-pox just the same as if no disease had been communicated to them from the cow; and all the medical practitioners in the country around him assured him that the cow-pox could not be relied on as a preventive. "This for awhile," says Jenner, "damped, but did not extinguish my ardour." Patient inquiry gradually led him to the truth, that the virus of the cow-pox underwent progressive changes, in the later of which it had so lost its specific property, that although it was capable of powerfully affecting the human body, it afforded no protection from attacks of the more serious disease.

Jenner's task was now simple. During his investigations into the nature of casual small-pox, he was naturally struck with the idea that it might be practicable to propagate the disease by inoculation, first from the cow and finally from one human being to another. He anxiously waited for some time for an opportunity of putting this theory to the test. The first person ever vaccinated was a lad of eight years old, named James Phipps, in whose arm was inserted some of the virus, taken from the arm of a young woman who had accidentally become infected while milking a cow. On inoculating the same lad some months afterwards, Jenner found, to his great joy, that no effect could be produced—that, in fact, it was impossible to communicate to his patient the small-pox. "While the vaccine discovery was progressive," says the great and good

Jenner, "the joy I felt at the prospect before me of being the instrument destined to take away from the world one of its greatest calamities, blended with the fond hope of enjoying independence and domestic peace and happiness, were often so excessive, that in pursuing my favourite subject among the meadows, I have sometimes found myself in a kind of reverie. It is pleasant to me to recollect that those reflections always ended in devout acknowledgments to that Being from whom this and all other blessings flow."

Jenner published the account of his discovery in 1798. In spite of ridicule and opposition from many of the medical profession, and of fanatical denunciations from the ignorant, it rapidly made its way. In 1802, Jenner, who had philanthropically thrown open his secret to the world, received from Parliament a vote of £10,000. In 1807 an additional grant of £20,000 was made to this great benefactor of mankind, and he had the happiness of living to see the notion of the poor dairymaid of Sudbury accepted throughout the civilized world.

EARLY AERONAUTS, AND TESTU'S BALLOON VOYAGE.

THE brothers Montgolfier, paper manufacturers at Annonay, about twelve leagues from Lyons, invented their well-known paper fire-balloon in 1782. After one or two experiments the present ciled silk was substituted for paper, but the principle of inflation was still that of producing rarefied air by a fire lighted under an aperture at the mouth of the balloon, exactly as in the paper balloon still sold at toyshops. In this perilous machine,

however, persons were soon found bold enough to leave the earth without the safeguard of ropes, which had previously been used. In 1783 the Marquis d'Arlandes and M. Montgolfier made the first genuine balloon ascent from Passy, near Paris, and after some alarming mishaps alighted safely in the environs of that city; but the dangerous character of these ascents, during which it was necessary to continually feed the fire under the balloon with straw carried with them by the aeronauts for that purpose, soon led to the invention of the hydrogen balloon. This differed from the Montgolfier in being filled with hydrogen gas, generated by the pouring of diluted sulphuric acid on iron filings. After being long abandoned, the old dangerous Montgolfier balloon has been revived by a Frenchman, M. Gouard, who very recently made a successful ascent in England with a balloon of gigantic construction inflated on that principle.

One of the earliest travellers in this improved balloon was M. Testu, whose ascent from Paris on the 12th of June, 1785, is one of the most curious episodes in the early history of balloon voyages from Paris. His balloon was twenty-nine feet in diameter, constructed by himself, of glazed tiffany, furnished with wings, and filled, as had now become the fashion, with hydrogen gas. It had been much injured by wind and rain during the night before its ascension, but having undergone a slight repair, it was finally launched with its conductor at four o'clock in the afternoon. The barometer then stood 29.68 inches, and the thermometer as high as eighty-four degrees, though the day was cloudy and threatened rain. The balloon had at first been filled

only five-sixths; but it gradually swelled as it became drier and warmer, and acquired its utmost distention at the height of 2800 feet. But to avoid the waste of gas, or the rupture of the balloon, the navigator calculated to descend by the reaction of his wings. Though this force had little efficacy, yet at half-past five o'clock he softly alighted in a corn-field in the plain of Montmorency. Without leaving the car he began to collect a few stones for ballast, when he was surrounded by the proprietor of the corn and a troop of peasants, who insisted on being indemnified for the damage occasioned by his idle and curious visitors. Anxious now to disengage himself he persuaded them that his wings being broken, he was wholly at their mercy. They seized the stay of the balloon, which floated at some height, and dragged their prisoner through the air in a sort of triumph towards the village. But M. Testu, finding that the loss of his wings, his cloak, and some other articles had considerably lightened the machine, suddenly cut the cord, and took an abrupt leave of the clamorous and mortified peasants. He rose to the regions of the clouds, where he observed small frozen particles floating in the atmosphere. He heard thunder rolling beneath his feet, and as the coolness of the evening advanced the buoyant power of his vessel diminished, and at three-quarters after six o'clock he approached the ground with his car near the abbey of Royaumont. There he threw out some ballast, and in the space of twelve minutes rose to a height of 2400 feet, where the thermometer stood only at sixty-six degrees. He now heard the blast of a horn, and descried some huntsmen below in full chase. Curious to

witness the sport he pulled the valve, and descended at eight o'clock between Etonen and Varville; when, rejecting his oars, he set himself to gather some ballast. While he was thus occupied, the hunters galloped up to him: He then mounted a third time and passed through a dense body of clouds, in which thunder followed lightning in quick succession. The thermometer fell to twenty-one, but afterwards regained its former point of sixty-six degrees, when the balloon had reached an altitude of 3000 feet. In this region the voyager sailed till half-past nine o'clock, at which time he observed from his watch-tower in the sky the final setting of the sun. He was now quickly involved in darkness, and enveloped in the thickest mass of thunder-clouds. The lightning flashed on all sides, and the loud claps were incessant. The thermometer, seen by the help of a phosphoric light with which he had provided himself, stood at twenty-one degrees, and snow and sleet fell copiously around him. In this terrible situation the intrepid adventurer remained the space of three hours, the time during which the storm lasted. The balloon was affected by a sort of undulating motion upwards and downwards, owing, he thought, to the electrical action of the clouds. The lightning appeared excessively vivid, but the thunder was sharp and loud, preceded by a sort of crackling noise. A calm at last succeeded, he had the pleasure to see the stars, and embraced this opportunity to take some necessary refreshment. At half-past two o'clock the day broke: but his ballast being nearly gone, he finally descended, at a quarter before four o'clock, near the village of Campremi, about sixty-three miles from Paris.

THE VALUE OF RUSTED IRON—MR. WEISS, THE
CUTLER.

ABOUT forty years ago an eminent London cutler, Mr. Weiss, of the Strand, the inventor of a number of valuable improvements in surgical instruments, observed that steel was much improved when it had become rusty in the earth, provided the rust was not factitiously produced by the application of acids. "Accordingly," says the author of the "Chronicles of Old London Bridge," to whom we are indebted for this curious anecdote, "he buried some razor blades for nearly three years, and the result fully answered his expectation. The blades were coated with rust, which had the appearance of having exuded from within; but the metal was not eaten away, and the quality of the steel was decidedly improved. It was assumed that the same principle holds good with respect to iron under similar circumstances, and with perfect confidence in the correctness of his views, Mr. Weiss determined to procure some old iron which had been subjected in an extraordinary degree to the action of rust. It happened at that time that the removal of old London Bridge offered a singular opportunity for the attainment of his purpose. The old materials were sold by auction, and among these were about fifteen tons of old iron, which the ingenious instrument-maker bid for with an eagerness which must have puzzled the other attendants of the sale, who, doubtless, regarded him as

a mere seeker of relics and curiosities. It was the iron with which the ancient piles, which had supported more than one such structure, were found to be shod, and it was supposed that they had been originally buried in the soil at the bottom of the river six or seven centuries previously. Each of these rudely-formed shoes or points consisted of a small inverted pyramid, with four straps rising from the four sides of its base, which were nailed to the pile—the total length from the point which entered the ground to the end of the strap being about sixteen inches, and the weight about eight pounds. The points of the shoes were found to be not much corroded, nor indeed were the straps; but the latter had become extremely and beautifully sonorous, closely resembling, it is said, in tone the bars and sounding pieces of an Oriental instrument which had been exhibited shortly before with the Burmese state carriage. Mr. Weiss discovered that while these straps, in addition to their sonorousness, possessed a degree of toughness quite unapproached by solid iron, the solid points had nothing to recommend them. They were convertible only into very inferior steel, while the straps, and even the bolts, which were, in fact, imperfect carburets, produced steel of a quality infinitely superior to any which in the course of his business Mr. Weiss had ever before met with. The “old pile” steel became in general request among the workmen for tools, while on the other hand they demanded higher wages, on account of its hardness, for working it. Ultimately the straps were separated from the solid points, and these last sold as old iron. At first it had been supposed, from the difference between the joints, that the shoes were composed of two sorts of iron; but

besides the improbability of this, the contrary was proved by an examination, and finally it was inferred that the extremities of the piles having been charred, the straps of iron closely wedged between them, and the tum in which they were imbedded, must have been subjected to a galvanic action, which in the course of some six or seven hundred years gradually produced the effects recorded.

THE AURORA BOREALIS AND THE TELEGRAPH

THE effect of the aurora borealis on electric telegraph lines is curious. In September, 1851, there was a remarkable aurora which took complete possession of all the telegraph lines in New England, in the United States, and prevented any business being transacted during its continuance. In February, 1852, another instance occurred. Towards evening a heavy blue line appeared upon the paper used by the operators, which gradually increased in size for the space of half a minute, when a flame of fire succeeded to the blue line, of sufficient intensity to burn through a dozen thicknesses of the moistened sheets. The current then subsided as gradually as it had come on, until it entirely ceased, and was then succeeded by a negative current (which bleached, instead of colouring the paper). This gradually increased, until it also, in turn, produced its flame of fire, and burned through many thicknesses of the prepared paper.

The effect of the aurora borealis, or magnetic storm, appears to be totally unlike that of common or free electricity, with which the atmosphere is charged during a thunder-storm. The electricity evolved during a thunder-storm, as soon as it reaches a conductor, explodes with a spark, and becomes at once dissipated. The other, on the contrary, is of very low tension, remains upon the wires sometimes half a minute, produces magnetism, decomposes chemicals, deflects the needle, and is capable of being used for telegraphic purposes, although, of course imperfectly.

The aurora borealis has in fact been used for transmitting and receiving telegraphic despatches. This almost incredible feat was accomplished in the forenoon of September 2, 1859, between the hours of half-past eight and eleven o'clock, on the wires of the American Telegraph Company, between Boston and Portland, and upon other lines in various parts of the country, as described by Mr. G. B. Prescott, the able superintendent of the American telegraph lines. The auroral influence was observed one day upon all the lines running out of the office in Boston, at the hour of commencing business (eight o'clock, A.M.), and it continued so strong up to half-past-eight, as to prevent any business being done, the ordinary current upon the wires being at times neutralized by the magnetism of the aurora, and at other times so greatly augmented as to render operations impracticable. At this juncture it was suggested that the batteries should be cut off, and the wires simply connected with the earth.

The current from the aurora coming in waves of that or less intensity, there were times, both while the

wave was approaching and while it was receding, when the instruments were enabled to work; but the time varying according to the rapidity of the vibrations, whatever business was done upon the wires during these displays, had to be accomplished in brief intervals of from a quarter to half a minute in duration.

During one of these intervals, the Boston operator said to the one at Portland, "Please cut off your battery, and let us see if we cannot work with the auroral current alone."

The Portland operator replied, "I will do so. Will you do the same?"

"I have already done so," was the answer. "We are working with the aid of the aurora alone. How do you receive my writing?"

"Very well indeed," responded the operator at Portland; much better than when the batteries were on; the current is steadier and more reliable. Suppose we continue to work so until the aurora subsides."

"Agreed," replied the Boston operator. "Are you ready for business?"

"Yes; go on," was the answer.

The Boston operator then commenced sending private despatches. The line was worked in this manner more than two hours, when, the aurora having subsided, the batteries were resumed.

SCHEMES FOR EXTINGUISHING FIRE.

ALL who have watched the progress of inventions know how difficult it is to depend upon preconceived experiments, as proofs of their efficacy, for attaining the results predicted by their sanguine authors. In the year 1776, a gentleman named Hartley announced that he had made a discovery which would for ever prevent those disastrous fires which had so often afflicted crowded cities. A house on fire was stated to be henceforth a thing of the past, while the parish engine and its custodians had from that time forward nothing to do but to enjoy a perpetual holiday. The accounts of this new discovery at length attracted the attention of King George III., who determined to visit the inventor at his house on Wimbledon Common, there to witness experiments illustrative of the plan. The King was accompanied by the Queen, the Prince of Wales, afterwards George IV., the Bishop of Osnaburgh, the Princess Royal, and the Princess Augusta, and several ladies and gentlemen of the court. The inventor received the distinguished party with much satisfaction, and proceeded at once to conduct them through a series of experiments which appeared to leave no doubt of the great benefits of his principle. The magazines of the time state that their majesties with the prince and princesses first breakfasted in one of the rooms; and that the tea-kettle was boiled upon a fire made upon the floor of the opposite room, which apartment they afterwards entered and saw a bed set on fire, the curtains of

which were consumed with part of the bedstead, but not the whole, the flames, from the resistance of the floor, going out of themselves. The king and queen then went downstairs and saw a horse-shoe forged in a fire made upon the floor, as also a large faggot lighted which was hung up to the ceiling. After this two fires were made upon the staircase, and one under the stairs; all which burnt out quietly, without spreading beyond the place where the fuel was first laid. The party paid the greatest attention to every experiment that was made, and expressed the utmost satisfaction at the discovery. The whole concluded by lighting a large magazine of faggots, pitch, and tar: it burnt with amazing fury, but did no damage to the floor or ceiling. It is stated that the queen and the children displayed the utmost courage and composure in going upstairs and remaining in the room immediately over that which was raging in flames beneath.

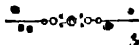
Mr. Hartley's plan, notwithstanding these apparently triumphant experiments, never became generally adopted, and is forgotten. It must be remembered that the inventor in conducting experiments of this kind is enabled to select all the conditions of the trial and to avoid difficulties which might occur in ordinary practice. Probably this is the reason why so little has been heard of late years of a kindred invention, Phillips's fire annihilator, the success of which appears to be still more completely demonstrated. About fifteen years ago, scientific men and public writers were invited to witness the effective power of this new invention for extinguishing fires. A numerous party accordingly assembled at the London gas-works, Vauxhall. The agent

by which it was sought to accomplish the object was a mixture of gas and vapour. After several experiments on a small scale, to show the success attained by these means, the attention of the company was directed to a compartment of a large open building, quite twenty feet high inside, which was fitted up with partitions and temporary joisting of light wood, well soaked with pitch and turpentine, and overhung beside with rags and shavings soaked in the like manner. The torch was applied to this erection, and the flames, which ascended immediately, at length roared with a vehemence which drove the spectators back to a distance of forty feet, and were already beyond the power of water. The inventor then brought forward one of his hand-machines, and threw out a volume of gaseous vapour, which in half a minute entirely suppressed all flame and combustion; and to show that the vapour which now filled the space was quite innoxious, Mr. Phillips mounted into the loft, and passed and repassed through the midst of it with a lighted candle in his hand. The machine with which this effect was accomplished was rather larger than a good sized coffee-pot, and consisted of three tin cases, one within another, and mutually communicating. There was a small quantity of water in the bottom of the machine, and in the centre case was a composite cake, of the size and colour of peat—containing in the middle of it a phial of sulphuric acid and chlorate of potash. In order to put the machine into action this phial was broken, and a gaseous vapour generated so rapidly and in such quantity that it immediately rushed out from a lateral spout with great impetuosity. The inventor explained that a machine of

any size could be made according to the purpose for which it was intended.

There can be no doubt that all these experiments were honestly conducted, and did really effect what they appeared to do; but nevertheless, great fires continue their destructive ravages, and the various fire brigades are, unhappily, not yet enabled to retire from their labours.

THE MODERN THIEF-CATCHER.



THERE can be no doubt that nothing has contributed more to render robbery a difficult and dangerous profession than the invention of the electric telegraph. The following curious entries appear in the telegraph book, preserved at the Paddington Station :—

“Paddington, 10.20 A.M.—Mail train just started. It contains three thieves, named Sparrow, Burrell, and Spurgeon, in the first compartment of the fourth first-class carriage.”

“Slough, 10.50 A.M.—Special train just left. It contained two thieves, one named Oliver Martin, who is dressed in black, and wears a black hat; the other named Fiddler Dick, in black trousers and light blouse. Both in the third compartment of the first second-class carriage.”

“Slough, 11.16 A.M.—Special train arrived. Officers have taken the two thieves into custody, a lady having lost her bag, containing a purse with two sovereigns

and some silver in it; one of the sovereigns was sworn to by the lady as her property. It was found in Fiddler Dick's watch-fob."

It appears that, on the arrival of the train, a policeman opened the door of the third compartment of the first-class carriage, and asked the passengers if they had missed anything. A search in pockets and bags accordingly ensued, until one lady called out that her purse was gone. "Fiddler Dick, you are wanted!" was the immediate demand of the police-officer, beckoning to the culprit, who came out of the carriage, thunderstruck at the discovery, and gave himself up, together with the booty, with the air of a completely beaten man. The effect of the capture so cleverly brought about is thus laconically entered in the telegraph book:—

" "Slough, 11.51 A.M.—Several of the suspected persons who came by the various down-trains are lurking about Slough, uttering bitter invectives against the telegraph. Not one of those cautioned has ventured to the Montem."

Another instance may be cited:—

One night, at ten o'clock, the chief cashier of the Bank of England received a notice from Liverpool, by electric telegraph, to stop certain notes. The next morning the descriptions were placed upon a card and given to a proper officer to watch that no person exchanged them for gold. Within ten minutes they were presented at the counter by an apparent foreigner, who pretended not to speak a word of English. A clerk in the office who spoke German interrogated him, when he declared that he had received them on the Exchange at Antwerp, six weeks before. Upon reference to the books, however, it appeared that the notes had only

been issued from the bank about fourteen days, and therefore he was detected at once as the utterer of a falsehood. An officer was sent for, who forthwith locked him up, and the notes were detained. A letter was at once sent to Liverpool, and the real owner of the notes came up to town. He stated that he was about to sail for America, and that whilst at an hotel he had exhibited the notes. The person in custody advised him to stow the valuables in his portmanteau, as Liverpool was a very dangerous place for a man to walk about in with so much money in his pocket. The owner of the property did so, but had no sooner left the house than his adviser broke open the portmanteau and stole the property. The thief was taken to the Mansion House, and could make no defence. The sessions were then going on at the Old Bailey. By a little after ten the next morning, such was the speed, not only was a true bill found, but the trial by petty jury was concluded, and the thief, thanks to the invention of the telegraph, sentenced to expiate his offence by ten years' transportation.

A REFINED-WITTED INVENTOR.

ALTHOUGH the elder Brunel left France very young, and resided in America some years before he came to England, he never completely overcame the difficulties of the English language. His accent indeed was far from faultless, but he had a ready command of words, and no

difficulty in expressing himself in an emergency. His daughter relates that when the Prince Regent, afterwards George IV., visited the works at Woolwich which Brunel had erected, he addressed the engineer with the words, "I remember Mr. Brunel perfectly, but Mr. Brunel has forgotten me." The latter bowed respectfully, and expressed his regret that he had been guilty of any omission. "The fact is," continued the Prince, "that some years ago, when you explained to me the block machinery at Portsmouth, you promised me a copying machine of your invention, but you forgot your promise, Mr. Brunel." Without any hesitation, the engineer, who was probably not displeased to have been so well remembered, replied, "Please your Royal Highness, I have never been able to perfect the machine so as to make it worthy of your acceptance." The very first patent he had taken out was for a duplicate writing and drawing machine, which was probably the invention referred to by the Prince: it was not till upwards of twenty years later that Brunel took a patent for his copying press, which was more successful.

On another occasion, when Brunel had to give evidence in a court of justice in a cause relating to a patent right, it was absurdly attempted to throw discredit on his testimony because he was a foreigner. Are you not a Frenchman, *Monsieur Brunel*?" asked the opposing counsel, with a triumphant glance at the gentlemen of the jury. "Oh, yes," replied the witness coolly; "I am from Normandy, the country from which your oldest nobility derive their titles."

Some gentlemen having applied to him to make a variety of machinery for applying a small water power

to sawing wood, cutting stone and marble, preparing oak-bark, etc., they expressed a hope that he would not think their notions extravagant or ridiculous. Brunel replied, "I see nothing ridiculous in your attempting to adapt a small power to many purposes--no more than to have many carts, and only one horse. It is not expected you will fasten them all together when you only want the use of one."

THE GEOLOGIST AND HIS HORSE.

UNLIKE William Smith, the "father of English geology," who being too poor to ride except when employed as a land-drainer, walked over a large part of England, the late Dr. Buckland had means to mount, and performed nearly all his geological excursions on horseback, the horse imbibing a decidedly geological taste. The doctor rode a favourite old black mare, who was frequently caparisoned all over with heavy bags of fossils and ponderous hammers. The old mare soon learnt her duty, and seemed to take interest in her master's pursuits; for she would remain quiet without any one to hold her, while he was examining sections and strata, and then patiently submit to be loaded with interesting but weighty specimens. Ultimately, she became so accustomed to her work, that she invariably came to a full stop at a stone quarry, and nothing would persuade her to proceed until the rider had got off and examined the

quarry. On one occasion Dr. Buckland was in ~~some~~ danger from the falling stones as he was climbing up the side of one of these quarries. He was told of his danger by the bystanders. "Never mind," said he, "the stones know me."

A STORY OF THREE WORKMEN.

A GREAT fire, which broke out in Paris in 1802, entirely destroyed the magnificent grain market, the cupola of which was regarded as one of the most remarkable structures in Europe, not merely for its vast dimensions, but for the novelty and ingenuity of the principle on which it was constructed. This cupola was entirely the work of three somewhat obscure artizans, whose names are scarcely remembered in history beyond the following anecdote:—At the time of the *fêtes*, given in Paris in honour of the birth of the dauphin son of Louis XVI., the great space enclosed by the circular building then known as the Halle aux Blés, was covered by an immense awning, presenting by the light of the illumination within a beautiful appearance. This sight made a powerful impression upon the imagination of two young architects, named Legrand and Molinos, who had recently returned from studies in Rome; one of whom remarked that it was a pity such a roofing could not be made permanent. The idea reached the authorities; who at once requested the young architects to undertake the task.

"It is impossible," replied M^rlings. "This vast building, with its twenty-five arcades, was designed by the famous Mezières, without any idea of its being called upon to support the enormous weight of such a roof as would be required."

"Nothing is impossible for genius," interrupted Le grand. "I know an enthusiastic workman, a mere joiner but a good mathematician, who would find some way to solve the problem. He has published a book about the joiner's art, and though few pay attention to him, he is one of the most able and original men of his time."

This man was the builder, Jacques Roubo, and the young architects lost no time in presenting their request to him.

"I care nothing for the reputation of originality," said Roubo, after listening respectfully to his visitors' statements. "My originality shall be simply that of having the courage to revive a plan which has been long forgotten, and which I think will accomplish what appears to you so difficult. Give me a day, and I will give you an answer."

On the following day Roubo made known his determination to undertake the construction of the cupola, on the condition that he should be at liberty to select his own workmen, and should have entire freedom to follow his own plans. This being assented to, he devised a plan suggested by the Chateau de la Muette, constructed by the celebrated Philip Delorme, which consisted in substituting for solid beams thin boards supporting each other, and going off from the edges of the walls in all directions. He had to help him in his difficult task

a carpenter named Albourg, and a blacksmith named Raguin, the latter of whom executed the fine iron lantern which formed the crowning point in the edifice. After only five months of labour, so well directed that not one human life was risked, the great work was completed on the 31st of January, 1783. The cupola was one hundred and twenty feet in diameter, its height being one hundred feet from the ground. Twenty-five openings filled with panes of glass divided the roof from top to bottom, and it appeared to the architects of the time almost impossible to conceive how the dome was sustained, divided as it was between wood and glass, and apparently of less than one foot in thickness. When the temporary supports were finally taken down, Roubo, full of confidence in the principle which had guided him, insisted on standing under a cornice, in order to examine the roof closely, and observe if it shook when left to its own resources. No one would share with him what everybody considered a great danger. The props were removed amid the acclamations of the people, and the intrepid Roubo was assured of the complete success of his undertaking. He was borne in triumph on the shoulders of the admiring citizens, the crowd pressing on all sides to gain a sight of the man to whom they owed a construction so novel.

Roubo, on this occasion, as well as on all others, showed himself to be as disinterested as he was skilful, renouncing what he might have claimed as originator of so great an enterprise, and accepting only the sum agreed upon as a remuneration for directing the work. Raguin, praising his own lantern one day to him, Roubo replied, "Don't mention it;

if I were only in your life, I would have made the whole cupola of iron" — an idea realized twenty-five years afterwards. Roubo's history is interesting. The son of a poor journeyman builder, he had been left to himself at an early age; nevertheless, endowed with a strong desire to raise himself above the circumstances in which he was placed, and conscious that improvement alone would do this, he applied himself diligently to study, although many difficulties stood in the way. The little money given him to buy food was for the most part laid out in the purchase of books and models for drawing; the harshest privations were unheeded by him, if he could buy books. When he began to work at his father's trade, he was still so poor, that when he sat up during the long winter nights for purposes of study he could not afford to pay for a lamp or candle, and was obliged to pick up pieces of tallow and fat thrown out by the neighbours and burn them. Such ardour did not remain long unfruitful. He was observed by Professor Blondel, a nephew of the celebrated architect of that name; and, from that time, he had a guide and a support. After giving him gratuitous lessons for five years, and otherwise encouraging and assisting him, Blondel had cause to be proud of his pupil.

THE STRUGGLES OF OPTICAL-GLASS—GUINAND OF BRENETS.

THE first artists and men of science on the Continent had failed in manufacturing glass exactly suited to the purpose of optical instruments, when about the middle of the last century, Dollond and the French and German opticians made experiments to discover the cause of this failure. They found it to be the necessity for avoiding any variation in the media of which the glass is composed; as the slightest difference acted as a disturbing cause to the progress of the ray of light, deranging the refraction and distorting the object. The Académie des Sciences in Paris offered prizes in vain for the overcoming of this difficulty. The celebrated chemists Roux of St. Gobain, and Anet of Langres, devoted their attention to it in vain; even when partially successful, a diameter of three inches or three inches and a half was the largest they could obtain. It remained for a man in no degree conversant with science, not a glass maker by trade nor distinguished by education, but endowed with wonderful energy, spirit of inquiry, and perseverance to arrive at the solution of the difficulty.

This man was Guinand, a poor peasant in the village of Brenets, in the canton of Neuchâtel in Switzerland. Like many of the villagers in Switzerland, Guinand partly employed his time as a workman in a branch of the watch trade. Watchmaking, from the necessity of continual close inspection with a magnifying glass into

minute portions of the work is proverbially injurious to the eyes; and Guinand, suffering from the common affliction of his trade, was compelled to wear spectacles. His poverty—for the earnings of the Swiss watch-makers were at this period extremely low—drove him to the resource of grinding spectacle-glasses for his own use. In this way he acquired some practical knowledge of the principle of lenses. Being of a very ingenious turn of mind the work interested him, and he began to make for his own amusement small refracting telescopes, which he mounted in pasteboard cases. One day visiting the shop of Droz, the master who employed him, at Chaux de Fonds, he was shown a small achromatic telescope of English manufacture, a more perfect instrument than he had ever seen before. Delighted with the object he obtained permission to examine it, and finally to take it to pieces, separate its lenses, and measure its curves. Satisfied that he had mastered the principle, Guinand resolved to attempt to imitate it, and communicated the intention to his master. Glass suited to the purpose could only be obtained in England; Droz, having occasion to visit this country to obtain a patent for his self-winding watches, brought back with him as much glass as enabled Guinand to construct several achromatic telescopes, which were entirely successful.

There was, however, still the great difficulty of bad glass, and the presumed impossibility of procuring optical glass of a large size. Even Sir Isaac Newton had pronounced these difficulties insurmountable. How, then, was a humble journey-worker to succeed in overcoming them? The question seemed unanswerable, but Gu-

and was in no way daunted. He had been accustomed to the fusing of metals in his own business, and had observed that in the ordinary process the waving and the threads similar to those seen in the fusing of glass were removed by stirring and thoroughly mixing the metal by means of an iron bar. This fact suggested the application of the same process to flint glass, and after many attempts made during his leisure hours the ingenious peasant succeeded in what had so long baffled the great scientific men of his time, the production of flint glass perfectly free from what are called striæ. From 1784 to 1790 he made almost daily experiments, melting down at each time about three or four pounds of glass, and keeping a careful record of all the facts which he observed. Having during this time abandoned his old branch of the watch trade for a more profitable one he obtained a better command of capital and leisure, and among the first results of his improved circumstances he purchased a piece of land on the banks of the Doubs where he constructed a furnace capable of fusing the large amount of two hundred weight of glass. Accidents and disasters long beset his course. His crucibles failed, his furnaces burst, but he renewed them, and repaired all defects with indomitable patience. At last he succeeded in obtaining large pieces of uniform quality, in one case reaching the size of eighteen inches in diameter. He also discovered the important art of soldering together pieces of good glass, altogether obliterating the line of junction. This he accomplished by first fusing them together, and then grinding out the globules of air or particles of sand on a wheel dusted with pow-

dered emery. Finally, he replaced the mass in a furnace, when the glass expanding and filling up the hollows, he was enabled to obtain with certainty the discs of flint glass larger than any that had yet been manufactured.

M. Utzschneider, of Munich, hearing the result of his experiments, on making further inquiry, proposed to him to join him and M. Fraunkoffer in their establishment at Munich; he accepted the offer, and one of the largest glasses resulting from their experiments is now in the Observatory at Dorpat.

Guinand returned to his own country, but not being a glass-maker by profession, he prosecuted his researches only at intervals. He had discovered the principle; had earned a well-merited reputation in the world of science, and promoted the researches of others; but the results of his experiments had not attained to certainty in practice, and he had not overcome the difficulties in the fabrication of crown-glass, which requires the same perfection and the same dimensions as the corresponding flint.

In the latter years of his life, Guinand entered into communication with the Astronomical Society of London, and sent over some discs of flint-glass, of which Messrs. Dollond, Herschel, and Pearson made a favourable report. It is remarkable that at this time, in the country which had supplied the Continent with flint-glass, a disc of six inches should have been considered a rarity.

Soon after, a commission, composed of Messrs. Herschel, Faraday, Dollond, and Roget, was instructed to pursue the inquiry as to the manufacture of flint-glass.

Mr. Faraday took the lead, both in his own laboratory and at the glass-works of Messrs. Pellatt, and could not fail of arriving at important conclusions. He changed the principle of fabrication, and produced a borate of lead of remarkable purity. The Lords of the Treasury had found it advisable to make a relaxation of the Excise laws in favour of the Royal Society, or persons acting for scientific purposes under that body. But, notwithstanding this regulation, the interference of the officers, and the delay in obtaining the necessary licence, proved so onerous and inconvenient, as completely to shackle their proceedings, and preclude all attempt to improve by means of experiment: and the question as to the fabrication of flint-glass being actively pursued in France and Switzerland, the Commission ceased from its labours.

Shortly afterwards M. Guinand died, bearing with him the secret of his process; but in Bavaria, the works in which he had taken part had been continued according to his system; and his wife and two sons had witnessed his experiments, and were desirous of availing themselves of their father's invention for their own advantage.

M. Bontemps, who had devoted much attention to the manufacture of glass generally, and particularly of such as is required for optical purposes, was introduced by M. Berthouls, of Paris, to one of the sons of Guinand, who was endeavouring to sell his father's secret in England, or in France. He formed an association with him, but did not succeed in arriving at any good result. The treaty was broken; but M. Bontemps, satisfied of the correctness of the principle if properly

applied, continued the experiments at his works without excluding Guinand; and in 1828 they succeeded in producing good flint-glass, and discs of from twelve to fourteen inches, besides a large quantity of smaller sizes. From that time the manufacture may be considered to have been established on a regular system. Pure discs of flint-glass were exhibited in the Great Exhibition of 1851, of twenty-nine inches in diameter, each weighing the enormous amount of two hundred weight.

GALVANI AND THE FROG.

GALVANI, a natural philosopher of Bologna, in Italy, was one day dissecting a dead frog while one of his pupils happened to be making experiments in electricity by his side. He observed that the muscles of the frog being exposed gave signs of motion whenever the nerves came in contact with the scapel, which acted of course as a metallic conductor. Galvani varied his experiments and dissected another frog, exposing the nerves which go down the spine into the legs, and wrapping them in a leaf of pewter. He applied to this one of the two points of a compass or a pair of scissors, and touched with the other the surface of the leg or thigh of the frog. Every time this was repeated it produced convulsive movements in the muscles, which were motionless when the process was repeated without communication with the pewter leaf. Galvani, who was a man of great an-

INVENTION AND DISCOVERY.

intelligence, discovered the existence of a new principle in this phenomenon, and originated the fertile branch of physics known by the name of Galvanism. The convulsions observed by him in frogs were not permanent, and could only be produced by contact with an instrument formed of two metals. After numerous experiments he discovered that a metallic communication must be established between the nerves and the muscles. Thus was the galvanic fluid, Nature's most powerful agent in all her operations on the surface of the globe, made known to man. Shortly afterwards, Volta, another philosopher, repeated Galvani's experiments, and discovered that electricity was developed by the mere contact of metals; and conceived the idea of constructing what has since, from the name of the inventor, been called the Voltaic pile. The quantity of electric fluid produced by the first contact of zinc, copper, and cloth, communicated itself to the second, and so on increasing with great energy as it accumulated to the end of the pile. The chemical effects of this instrument he found to be very remarkable, it decomposed water, oxides, acids, and all salts. The chief merit of Volta's discovery was that it demonstrated the fact that the principle of the phenomena observed by Galvani was in the metals themselves, and not in the nerves of the animal. In this the cause of the movements he had noted was simply a current of electricity passing along the nerves and muscles. This gave rise to the term Voltaic Electricity, and finally led to the perfecting of the electric telegraph.

THE PIONEERS OF STEAM NAVIGATION.

THE idea of moving a vessel in the water by means of paddle-wheels, appears to be of great antiquity. The boats by which the Roman army under Claudius Codrus was transported into Sicily were propelled by wheels moved by oxen; and in many old military treatises the substitution of wheels for oars is mentioned. One of the earliest of the dreams of our own inventors was that of making ships move by mechanical power, and without the assistance of wind and tide, and many ingenious designs were published professing to accomplish that object. Thomas Savery obtained a patent in 1696 for a paddle-wheel to be fixed on each side of a ship, to be turned by men by means of a capstan. Papin, Jonathan Hulls, Bernoulli, and others, also suggested schemes foreshadowing the use of steam in navigation; but all these notions were fruitless, before the invention of a steam-engine producing a continued rotative or circular motion, fitted to turn the paddle-wheels with the necessary force. Six years after Watt took out the patent for his sun and planet motion, Mr. Patrick Miller, of Dalswinton, published a pamphlet detailing a plan for propelling a double sailing boat, invented by him, by means of paddle-wheels; but the motive power he proposed to employ at that time, was simply the tedious one of men turning a capstan. Several experiments with this kind of power were tried, but they were found to become so much exhausted with the labour of turning the capstan, as

render the scheme profitable. It was during a conversation on the subject of these experiments at the house of Mr. Miller at Dalswinton, in the year 1787, that Mr. James Taylor, a gentleman living in Mr. Miller's family as tutor to his sons, suggested the substitution of the newly-invented steam-engine for the rude contrivance of manual labour. Mr. Miller appears to have been at first disinclined to adopt the suggestion, on the ground that when chiefly wanted to give aid, that is to say in time of storms, it would prove useless; Mr. Miller adding, "In such cases as that disastrous event which happened lately of the wreck of a whole fleet upon a lee shore, off the coast of Spain, every fire on board must be extinguished."

Fortunately, however, it was determined to try the experiment. "At this time," says Mr. Taylor, in his narrative of this affair, "William Symington, a young man employed at the lead mines at Wanlockhead, had invented a new construction of the steam-engine by throwing off the air pump. I had seen a model work and was pleased with it, and thought it very answerable for Mr. Miller's purpose. Symington had come into Edinburgh that winter for education; being acquainted with him I informed him of Mr. Miller's intentions and mine, and asked if he could undertake to apply his engine to Mr. Miller's vessels, and if he could I would recommend him. After some conversation Symington engaged to perform the work, and Mr. Miller agreed to employ him. It was finally arranged that the experiment should be performed on the lake at Dalswinton in the ensuing summer (1788). Accordingly, in the spring after the classes of the college broke up, I re-

remained in town to superintend the castings, etc., which were done in brass by George Watt, founder, at the back of Shakspeare Square. When they were finished I sent the articles to the country and followed myself. After some interval I took Symington with me to Dalrymple to put the parts together. This was accomplished about the beginning of October, and the engine, mounted in a frame, was placed upon the deck of a very handsome double pleasure boat upon the lake. We then proceeded to action, and a more completely successful and beautiful experiment was never made by any man, at any time, either in art or science.

The boat was composed of two small deck boats placed side by side, and joined together according to a plan which was believed by Mr. Miller to secure greater speed and other advantages. The vessels were only twenty-five feet long, and seven broad, and the tiny engine, the cylinders of which were only four inches in diameter, was placed upon a platform between the two boats, which it was found to move easily along at the rate of five miles an hour. The experiment was repeated shortly afterwards with another boat and a speed of six and a half or seven miles an hour having been obtained, a narrative of the experiments was drawn up by Mr. Taylor and published in the *Caledonian Mercury* and other papers. Small as was the scale on which these experiments were conducted, they demonstrated for the first time the possibility of moving a vessel continuously without the aid of, and even in opposition to, wind or tide. Mr. Miller was not unaware of the stupendous results to be anticipated from such an invention, but the kind of engine employed was regarded

by him as not adapted for the purpose of practical steam navigation. The experiments were suspended, and after amusing themselves for a few days on the lake with the first steamboat ever employed, the inventors removed the engine employed in the original experiment and carried it into the house of Mr. Miller where it remained an ornamental piece of furniture for many years.

It is, in fact, as satisfactorily shown by Mr. Bennet Woodcroft, to the perseverance of the young mechanic employed at the lead mines at Wanlockhead, that we owe the construction not of a mere philosophical toy but of a really practical steamboat. In the year 1801 Thomas, Lord Dundas, of Kerse, having heard of the Dalswinton trials, employed Mr. Symington to make a series of experiments on steamboats with a view to enable them to be substituted for the horses then employed to draw vessels on the Forth and Clyde canal. These experiments occupied more than two years, and are said to have cost more than seven thousand pounds. The result of these efforts was the construction of the "Charlotte Dundas," so named from his lordship's daughter—"a vessel," says Mr. Woodcroft, "which from the simplicity of its machinery, might have been at work to this day with such ordinary repairs as are now occasionally required to all steamboats." In this vessel there was an engine with the steam acting on each side of the piston (Watt's patented invention), working a connecting rod and crank, Pickard's patent, and the union of the crank to the axis of Miller's improved paddle-wheel, which was Symington's own invention. Thus had Symington combined together for the first time, those improvements which constitute

the present system of steam navigation. Having a number of noblemen and gentlemen aboard, and towing two vessels each of seventy tons burden, the "Charlotte Dundas" moved easily for nineteen miles and a half, in the face of a strong gale which prevented any other vessel being even towed by horse power to windward that day. Although an objection was raised on account of the damage done to the banks by the waves created by the paddles, the Duke of Bridgewater gave an order to Symington to build eight boats similar to the "Charlotte Dundas" to ply on his canal. It is stated that Symington returned to Scotland elated with the prospect of being able to introduce steam navigation in a short time, and to realize to himself the advantages which his ingenuity and unwearied perseverance gave him reason to anticipate; but he was doomed to disappointment, for on the same day that he was informed by Lord Dundas of the final determination of the committee not to allow steamboats to be employed on the canal, he received intelligence of the death of the Duke of Bridgewater. Unable longer to struggle against his misfortunes, his resources being exhausted, he was obliged, with great reluctance, to lay up his boat in a creek of the canal, where it remained for a number of years exposed to public view.

Mr. Taylor's widow subsequently received a pension from the government, granted by the late Lord Liverpool, and in 1837 each of his four daughters received a gift of £50 through Lord Melbourne. Mr. Miller, who was a wealthy man sought no pecuniary aid. On the whole it cannot be said that the pioneers of steam navigation received rewards from the state commensurate with

the great services which they rendered to the world. Symington presented a memorial to the Lords of the Treasury in 1825, in consequence of which the sum of one hundred pounds was awarded to him from Her Majesty's privy purse, and a year or two afterwards a further sum of fifty pounds; but in the decline of his life he was chiefly supported by a trifling sum allowed him by the steamboat proprietors, and by the assistance of a few relatives and friends.

The year 1812 is memorable as the year in which a practical steamboat was first constructed to ply for hire. This was the "Comet" steam passage boat, designed by Mr. Henry Bell, of Helensburgh. It was a vessel of thirty tons burden, only propelled by a steam engine driving two paddle-wheels on each of her sides. The engine was estimated at three-horse power. Having built and launched this vessel on January 18, 1812, Mr. Bell exhibited the following placard on the 5th of August in that year:—

"STEAM PASSAGE BOAT THE 'COMET,' BETWEEN GLASGOW, GREENOCK, AND HELENSBURGH, FOR PASSENGERS ONLY.

"The subscriber having, at much expense, fitted up a handsome vessel to ply upon the river Clyde, between Glasgow and Greenock, to sail by the power of the wind, air, and steam, he intends that the vessel shall leave the Broomielaw on Tuesdays, Thursdays, and Saturdays, about mid-day, or at such hour thereafter as may answer from the state of the tide; and to leave Greenock on Mondays, Wednesdays, and Fridays, in the morning, to suit the tide. The elegance, comfort, safety, and speed of this vessel require only to be proved to meet the

approbation of the public; and the proprietor is determined to do everything in his power to merit public encouragement. The terms are, for the present, fixed at four shillings for the best cabin, and three shillings the second; but beyond these rates nothing is to be allowed to servants, or any other person employed about the vessel. The subscriber continues his establishment at Helensburgh Baths, the same as for years past, and a vessel will be in readiness to convey passengers to the 'Comet' from Greenock to Helensburgh. Passengers by the 'Comet' will receive information of the hours of sailing by applying at Mr. Frouster's Office, Broomielaw; or Mr. Thomas Blackney's, East Quay Head, Greenock.

"HENRY BELL."

Mr. Bell's enterprise and speculation for the first year turned out a losing one; for so great, says he, was the prejudice against steam-boat navigation by the hue and cry raised by the fly-boat and coach proprietors, that for the first six months very few would venture in her. But in the course of the winter of 1812, as she had plied all the year she began to gain credit; as passengers were carried twenty-four miles as quick as by the coaches and at a third of the expense, besides being warm and comfortable. But even after all, he was a great loser that year. In the second year, he made her a jaunting boat all over the coasts of England, Ireland, and Scotland, to show the public the advantage of steam boat navigation over the other mode of sailing.

Two years after the launching of the "Comet," Mr. George Dodd, an enthusiastic engineer and designer of steamboats, successfully navigated a new vessel named

the "Majestic," from Port Glasgow in Scotland to Dublin, and thence, round the Land's End in Cornwall to the Port of London. It was chiefly, owing to Mr. Dodd's exertions that steam vessels were regularly established on the Thames in the year 1814. In 1817 five of these vessels were plying for passengers under Mr. Dodd's directions; two between London and Richmond, two between London and Gravesend, and two between London and Margate. A large number of serious accidents by fire and the bursting of the boilers of the high pressure engines then in use, led to a Parliamentary inquiry in 1817, but in spite of adverse witnesses and the organized opposition of the Thames watermen, the cause of steam navigation rapidly gained ground, and the committee inserted in their report the following memorable words:—

"Your committee entered on the task assigned them with a strong feeling of the inexpediency of legislative interference with the management of private concerns or property, farther than the public safety should demand, and more especially with the exertions of that mechanical skill and ingenuity, in which the artists of this country are so pre-eminent, by which the labour of man has been greatly abridged, the manufactures of the country carried to an unrivalled perfection, and its commerce extended over the whole world.

"Among these, it is impossible for a moment to overlook the introduction of steam as a most powerful agent, of almost universal application, and of such utility, that but for its assistance, a very large portion of the workmen employed in an extensive mineral district of this kingdom, would be deprived of their subsistence.

"A reference to the evidence taken, will also show with what advantage this power has lately been applied, in Great Britain, to propel vessels both of burthen and passage; how much more extensively it has been used in America, and of what farther application it is certainly capable, if it may not be said to be even now anticipated in prospect."

THE HUMOROUS SIDE OF TELEGRAPHY.

THE despatches which pass over a telegraph line says a practical manager of an extensive system of telegraphy, if collected together, would present a very curious and interesting volume of correspondence. The price of the transmission of a message depending upon the number of words which it contains, of course renders the construction of it necessarily as brief as possible. Most despatches are contained in less than ten words (exclusive of address and signature, which are not charged for), and it is surprising how much matter is often contained in this brief number.

A lady, desirous of ascertaining when her husband would return home, sent him a message making the inquiry; to which he responded, that important business detained him, and that he could not leave for some days.

The lady immediately replied by sending him another despatch in the following laconic manner.—

"At home, August 12, 1859.

"To F. C. P.—Despatch received. Deuteronomy
xxiv. 5."

"(Signed) KATE."

The gentleman to whom the despatch was addressed, upon referring to the passage in the Scriptures alluded to, obtained the following lengthy and suggestive epistle:—

“When a man hath taken a new wife, he shall not go out to war, neither shall he be charged with any business: but he shall be free at home one year, and shall cheer up his wife which he hath taken.”

The second example is a reply sent to a person who, having committed some offence against the laws, and run away, was desirous of ascertaining, if it would be prudent for him to return. He therefore telegraphed in the following laconic style:—

“To B. C. M.,—Is everything O. K.?” “July 4, 1859.”

“D. T. M.”

To which he obtained the following brief reply:—

“To D. T. M.,—Proverbs, chap. xxvii. 12.” “July 4, 1859.”

“B. C. M.”

Upon reference to the passage indicated, the inquiring individual obtained the following valuable advice, which, it is to be presumed, he followed:—“A prudent man foreseeth the evil, and hideth himself; but the simple pass on, and are punished!”

THE HISTORY OF PAPER-HANGINGS.

FLOCK paper-hangings were first manufactured in England, and invented by Jerome Lanyer, who obtained a patent in the reign of King Charles I., and carried on

his art in London. In this patent it is stated, that by his endeavours he hath found out an art and mystery of affixing wool, silk, and other substances, with oil, size, and other elements, to make them useful for hangings and other occasions, which he calleth Lendriniana, and that the said art is of his own invention. M. Savary, in his "Dictionary of Commerce," 1720, says that flock-hangings were first made at Rouen, but in a coarse manner, being only used for grounds, on which, with flocks of different kinds, were formed designs of brocades. They essayed to imitate tapestry-hanging, but not satisfactorily; and at last a manufactory was established at Paris, in the Faubourg St. Antoine, and there flowers and grotesques were introduced with success. His descriptions, detailing the manufacture of flock-hangings, do not allude to the use of paper as a ground, nor to blocks for printing. A French author, writing in 1723, says that paper-hangings, called tapestry in paper, were, till lately, only employed by the country people for their cottages, or by small tradesmen in their shops or rooms; but towards the end of the seventeenth century, the manufacture was raised to such a point of perfection and beauty, that, besides the quantities that were exported abroad, and to the principal cities of the kingdom, there was scarcely a house in Paris not decorated with it. In England this manufacture continued from the time of Lanyer, and obtained a high reputation.

In 1712, a duty of 1*d.* per square yard was imposed; and a Mr. Jackson, who established a factory at Battersea for paper-hangings of classic design in chiaro-oscuro, wrote, in a work published in 1754, in

praise of his own productions, and condemning the fanciful paper-hangings at the time so much used, comparing them with the Chinese. In the year 1786, there was established at Chelsea a manufactory for paper-hangings of a very superior description, by George and Frederick Eichardts. Works excelling even those of the present day were produced at this place. Some of the blocks used still exist, which are said to have great merit in the designs, and are, some of them, eight feet in length. These manufacturers carried the art to its highest point in England: they printed, not only on paper, but also on silk and linen, and employed a number of artists, in addition to workmen and children. The discovery of how to make paper in continuous lengths, and the repeal of the paper duty, have since then converted this once luxurious decoration into an almost universal covering for walls.

A GREAT INVENTOR'S RECREATIONS.

It is remarkable that the designer of the Thames Tunnel, whose name is identified with gigantic undertakings, was also the inventor of some of the most beautiful and delicate machines which have delighted the visitors to our great exhibitions. Many loiterers at South Kensington in 1862 stopped before a neatly dressed young woman, who amidst the whirling and screaming of innumerable machines of vast dimensions, sat thoughtfully clipping off neat balls of cotton as they grew under her hand with marvellous rapidity. First a

point, then a little pea; then, almost too quickly for the eye to detect it, the cotton balls, wound with beautiful regularity, formed themselves, while the young woman with her scissors, never forgetting her task for a moment, severed them one after the other, knowing the exact moment when to clip the thread and let fall into a basket below the balls, which were always found to contain the same number in a pound weight. This machine was among the earliest efforts of the inventive genius of Marc Isambard Brunel. It gave at once a marvellous impulse to the employment of cotton spinning; for with the common sorts of cotton the cost of wooden reels was now unnecessary, and everybody could tell by weighing, in a moment, how much of actual cotton he had obtained for his money. Brunel's machine measured the length of the thread which is wound, and proportioned the size of the ball exactly to its weight and fineness. Unhappily for the ingenious inventor, he neglected to secure the benefit of his idea, and while fortunes were realized through its means, he himself remained without any reward. Nearly sixty years ago, when he visited the workshops of Messrs. Strutt, at Belper, in Derbyshire, where there were six hundred and forty persons employed, he wrote in his diary, "I observed they had adopted my contrivance for winding cotton into balls. There were about twenty spindles on one swing."

A lady, a friend of Brunel, having once expressed her admiration to him of the little cotton balls, then a novelty, suggested to him jokingly that he ought to devise something to save the ladies the trouble of hemming and stitching. The remark was forgotten by

the lady, until one day she was shown a new machine, not that famous sewing machine which has since delighted so many beholders, but an expressly ingenious patent for trimmings and borders for muslins, lawns, and cambrics. The inventor's account, in his specification, of its advantages was, "that the operations of hemming, whipping, or otherwise securing from ravelling the edges of trimmings cut in narrow slips out of border webs, as they have unavoidably been hitherto, were by this invention altogether saved."

"Admirable!" exclaimed the lady; "but are you the inventor of this too?"

"The inventor, but not the originator," returned her visitor, perceiving that his questioner had forgotten the conversation which had been so fruitful in his mind.

"Indeed! who then was the originator?"

"Yourself, madam," replied Brunel; and the circumstances of their previous conversation flashed upon the lady's mind in a moment.

The comparison to the elephant's trunk, which is equally capable of raising a great bulk, or of picking up a pin, was never more aptly made than in the case of Brunel. He found amusement, amidst his grander schemes, in devising a number of little inventions for obviating some trifling inconvenience in daily life. An aged friend of his finding a difficulty in shuffling cards for whist, a game in which she found recreation, Brunel invented, expressly for her use, a card shuffler; the precise form of which is now forgotten. The cards were placed in a box, the handle was turned, and in a few seconds the sides of the box opened, presenting the

pack divided into four parts, and the cards effectually mixed. This ingenious machine was presented by Brunel to Lady Spencer.

FOLEY THE FIDDLER, AND THE INTRODUCTION OF SPLITTING MILLS IN NAIL-MAKING.



THE most extraordinary and the best attested instance of enthusiasm in conjunction with perseverance, says Coleridge, is related of the founder of the Foley family. This man, who was a fiddler, living near Stourbridge, was often witness of the immense labour and loss of time, caused by dividing the rods of iron necessary in the process of making nails. The discovery of the process called splitting-mills, was first made in Sweden, and the consequences of this advance in art were most disastrous to the manufacturers of iron about Stourbridge. Foley, the fiddler, was shortly missed from his accustomed rounds, and was not again seen for many years. He had mentally resolved to ascertain by what means the process of splitting bars of iron was accomplished; and, without communicating his intention to a single human being, he proceeded to Hull, and thence, without funds, worked his passage to the Swedish iron port. Arrived in Sweden, he begged and fiddled his way to the iron foundries, where, after a long time, he became a universal favourite with the workmen; and, from the apparent entire absence of intelligence, or anything like ultimate object, he was received into the

works, to every part of which he had access. He took the advantage thus offered, and having stored his memory with observations and all the combinations, he disappeared from amongst his kind friends as he had appeared—no one knew whence or whither. On his return to England he communicated his voyage and its results to Mr. Knight, and another person in the neighbourhood, with whom he was associated, and by whom the necessary buildings were erected, and machinery provided. When at length everything was prepared, it was found that the machinery would not act; at all events, it did not answer the sole end of its erection—it would not split the bar of iron. Foley disappeared again, and it was concluded that shame and mortification at his failure, had driven him away for ever. Not so: again, though somewhat more speedily, he found his way to the Swedish iron works, where he was received most joyfully, and, to make sure of their fiddler, he was lodged in the splitting-mill itself. Here was the very end and aim of his life obtained beyond his utmost hope. He examined the works, and very soon discovered the cause of his failure. He now made drawings, or rude tracings, and having abided an ample time to verify his observations, and to impress them clearly and vividly on his mind, he made his way to the port, and once more returned to England. This time he was completely successful, and by the results of his experience, enriched himself and greatly benefited his countrymen.

THE BEGINNING AND END OF PARACHUTES.

THERE can be no doubt that the first idea of the parachute was taken from the umbrella, or rather the parasol. Father Lohbère, in his curious account of Siam, relates that a person, famous in that remote country for his dexterity, was accustomed to divert the King and the royal court by the prodigious leaps which he took, having two umbrellas with long slender handles fastened to his girdle. He generally alighted on the ground, but was sometimes carried by the force of the wind against trees and houses, and not unfrequently into the river. Not a great many years ago the umbrella was, at least on one occasion, employed in Europe with similar objects, as well as in America. In the campaign of 1793 a French general, named Bournonville, having been sent by the National Convention, with four more commissioners, to treat with the Prince of Saxe-Coburg, was, contrary to the rules of war, detained a prisoner with his companions and sent to the fortress of Olmutz, where he suffered a rigorous confinement. In this cruel situation, he made a desperate attempt to regain his liberty. Having provided himself with an umbrella he jumped from a window forty feet high, but being a very heavy man, this screen proved insufficient to let him down safely. He struck against an opposite wall, fell into the ditch, and broke his leg, and was carried in this condition back again to his dungeon.

Blanchard was the first person who ever constructed a parachute, for the purpose of using it with a balloon in cases of accident while aloft. During an excursion which he took from Lisle about the end of August, 1785, when he traversed, without halting, a distance not less than three hundred miles, he let down a parachute with a basket fastened to it containing a dog, from a great height, which fell gently through the air, and conveyed the animal to the ground unhurt. Since that period the practice and management of the parachute have been carried much farther by other aeronauts, and particularly by M. Garnerin, who repeatedly descended from the region of the clouds, with that very slender machine. This ingenious Frenchman visited London during the short peace of 1802, and made two ascents, with his balloon, in the second of which he let himself fall from an amazing elevation with a parachute. This consisted of thirty-two gores of white canvas formed into a hemispherical shape of twenty-three feet in diameter, and having a hole in its centre admitting short pieces of tape to fasten it to the several gores. About four feet and a half below the top a wooden hoop, of eight feet diameter, was attached by a string from each seam; so that when the balloon rose, the parachute hung like a curtain from this hoop. Below it was suspended a cylindrical basket covered with canvas, about four feet high and two and a quarter wide. In this basket the aeronaut, dressed in a close jacket and a pair of trowsers, placed himself and rose majestically from an enclosure near North Audley Street, at six o'clock in the evening of the 2nd of September. After hovering seven or eight minutes in the upper region of the atmosphere; he médi-

seated in it. By means of this latter contrivance two men, in 1819, travelled in a cart, weighing with its load sixteen hundred weight, twenty-seven miles in one day, the journey including two long and steep hills. This cart was practically employed by the Doctor, to the great astonishment of the country folks of the neighbourhood, in conveying necessities from the market town to his farm. Besides these he suggested a method for preventing the forgery of bank-notes, by sending to India a paper-maker, who, combining his own knowledge of the art with the Oriental practice, might produce a paper which it would be impossible to imitate. He also made many experiments on the effect of sugar in fattening sheep quickly, and showed that it would be a profitable practice if sugar could be had for fourpence a pound, which it may be remarked is considerably above the price of coarse sugar when free from duty. He discovered that a solution of common salt would arrest and prevent mildew in wheat, and when at Woburn he made numerous experiments on the effect of manures, the results of which he communicated to the public in an essay on the subject. The poet Crabbe, who was personally acquainted with this ingenious man, says:—
“ Few persons could tell a good story so well, no man make more of a trite one. I can remember him, the portly dignified old gentleman of the last generation, grave and polite, but full of humour and spirit.” He died in 1823 at Hastings, in his eightieth year, and was buried at the parish church of Battle, where a monument is erected to his family.

Dr. Cartwright belonged to a family, who appear to have been distinguished by their ingenuity and science.

'bent violence.' His father, Mr. John Cartwright, of Marnham, was a man of great energy. He was remembered as among those who chiefly aided in putting an end to the system of giving "vails," as the exorbitant gifts of money to servants were then called, a system which had become so burdensome as to render it impossible for any but the rich to visit at the houses of distinguished persons. Dr. Cartwright's elder brother was long celebrated as the advocate of parliamentary reform. Hazlitt gives an interesting sketch of him as the "man of one idea" in his "Essays." Another brother, Charles Cartwright, was an officer in the navy, of whom it is related that he refused to accept prize money amounting to upwards of one thousand pounds allotted to him after an engagement, and insisted on its being divided among the sailors who had served with him on the occasion. Dr. Cartwright's other brother, George, was a distinguished officer in the army, who acted as aide-de-camp to the Marquis of Granby; and who published in 1792, at Newark, in Nottinghamshire, a valuable work in three quarto volumes, entitled, "A Journal of Transactions and Events during a Residence of nearly Sixteen Years on the Coast of Labrador," which for the first time gave an accurate account of the life and habits of the Esquimaux tribes.

THE LAYING OF THE GREAT ATLANTIC CABLE.

It was in the latter part of the month of July, 1857, that the "Niagara" and "Agamemnon," the latter a vessel of war lent by the British Government for the purpose, sailed for Queenstown, on the coast of Ireland, having aboard each one half of the great Atlantic Cable, to be laid down between the Old and New Worlds. While the two vessels lay about a quarter of a mile apart in the Cove of Cork, their cables were passed to each other, temporarily joined, and for the first time a circuit was established through two thousand five hundred unbroken miles of submarine wires. The "Niagara's" being attached to the galvanometer, the "Agamemnon's" brought directly to the battery, an electrical current was found to pass immediately, though at first slowly, thus at once putting at rest the anxious question of transmission through such an extraordinary length of wire. It was at first intended that the two vessels should proceed to mid-ocean, and then, having spliced the cable, should separate and steer one for Newfoundland, the other for the coast of Ireland. At the last moment this plan was changed, and it was determined that the "Niagara" should commence laying down the cable from the Irish coast westward, that she should be accompanied by all the vessels of the fleet, and that reaching mid-ocean they should join cables. An argument in favour of this arrangement was that one end of the cable being ashore, it could not be all lost in event of an accident. It was further considered

that by this plan there would be much less weight of cable to be sustained at any one time. Then the vessels of the fleet would be together, ready to give each aid in any emergency, and the work, so it was believed, could be more satisfactorily performed by this than by the mid-ocean arrangement.

After several experimental trips, improvements in the paying-out machine in the method of coiling, and other matters upon which the managers of the enterprise had obtained dear-bought experience, the gallant vessels again set sail in June, 1858, deeply sunk in the water with their enormous freights. New misfortunes, however, awaited them. After having been three days at sea, the expedition was overtaken by a fearful gale, which continued without intermission for nine days. On the ~~sixth~~ ^{ninth} day of this heavy weather, the ships, which continued to keep together, had to part company, and the "Agamemnon" was obliged to scud before the wind for thirty-six hours; her coils got adrift, and a coil of her cable shifted, so that her captain for some time entertained serious apprehensions for her safety, and from the immense strain her waterways were forced open, and one of her ports was broken. Two of the sailors were severely injured, and one of the marines lost his reason from fright. Yet such was the consummate skill, good seamanship, and intrepidity of her commander, Captain Priddle, that he was enabled to bring her to the appointed rendezvous, lat. 52° 2', long. 33° 18'. The "Niagara" rode out the storm gallantly, having only carried away her jib-boom and one wing of the figure-head, the American Eagle.

Arrived at their rendezvous the splice was made, and

the two vessels steamed away; but scarcely had they got out of sight of each other ere the cable broke, to the intense disappointment of all on board. In the great gale which the "Agamemnon" had encountered her vast unmanageable coil of cable had shifted, and become a mere shapeless, tangled mass, with which it seemed impossible to deal in any way; but this difficulty was surmounted by the indefatigable zeal of the officers and men of science aboard. Again and again, however, the cable parted, and the magno-electric current refused to pass. After hauling up, cutting, and resplicing with indomitable patience, they were compelled to return again unsuccessful. The expedition had not only ended, but three hundred miles of the valuable cable had been lost in mid-ocean during this second trial. The credit of the company fell rapidly, and the Atlantic cable was virtually consigned to the long catalogue of impracticable failures. Still the managers of the enterprise did not falter. They had provided an extra supply of wire in case of loss, and more than enough to compass the ocean yet remained. The summer was passing, and no time was to be lost; and on Saturday, the 17th July, the high-spirited men who had been so unfortunate with the previous attempt, again sailed upon their mission. Few persons in England or America had any hope of a good result; but suddenly at noon on the 5th of August the city of New York was electrified by the announcement of the arrival of the "Niagara" with the tidings that the Atlantic cable was safely laid. Men were generally incredulous; even the sanguine shook their heads in doubt. But the news was confirmed: the confirmation was immediately tele-

graphed to all parts of the United States, and the whole country broke out in uproarious rejoicings. Bells were rung, bonfires blazed, business ceased, illuminations were seen, and the press everywhere discussed the news so important to the American people. Finally, on the 16th of August, the tidings reached New York from Newfoundland that the Queen's message, which it had been arranged should be the first through the wires, had been received. It was as follows:—

— “TO THE PRESIDENT OF THE UNITED STATES, WASHINGTON.

“The Queen desires to congratulate the President upon the successful completion of this great international work, in which the Queen has taken the deepest interest.

“The Queen is convinced that the President will join with her in fervently hoping that the Electric Cable which now connects Great Britain with the United States, will prove an additional link between the nations whose friendship is founded upon their common interest and reciprocal esteem.

“The Queen has much pleasure in thus communicating with the President, and renewing to him her wishes for the prosperity of the United States.”

To this the President returned the following reply, also transmitted through the wires:—

“Washington City, Aug. 16, 1858.

“TO HER MAJESTY VICTORIA, QUEEN OF GREAT BRITAIN.

“The President cordially reciprocates the congratulations of Her Majesty the Queen, on the success of the

great international enterprise accomplished by the science, skill, and indomitable energy of the two countries. It is a triumph more glorious, because far more useful to mankind, than was ever won by conqueror on the field of battle.

"May the Atlantic Telegraph, under the blessing of Heaven, prove to be a bond of perpetual peace and friendship between the kindred nations, and an instrument destined by Divine Providence to diffuse religion, civilization, liberty, and law throughout the world. In this view will not all nations of Christendom spontaneously unite in the declaration that it shall be held sacred in passing to their places of destination, even in the midst of hostilities?

"JAMES BUCHANAN."

Thus, though unhappily only for the brief space of twenty-three days, the two continents were placed in instantaneous communication with each other; but it was already known that the insulation was defective, owing, it is said, from the cable being coiled during its manufacture in large vats and exposed to the heat of a summer's sun, intensified by the tarred coating of the cable, by which the gutta percha was melted and worn bare in various places. Before the communication ceased entirely one hundred and twenty-nine messages had been sent from Valentia, in Ireland, to Newfoundland; while the number sent from Newfoundland to Valentia was two hundred and seventy-one, making a total of four hundred messages sent across the Atlantic. Among these messages was one from the Horse Guards, London, countermanding the return of the sixty-second.

regiment, which, by avoiding the shipment and transportation of troops, saved fifty thousand pounds to the British Government.

THE END OF LAVOISIER.

THE great French chemist, Lavoisier, did not escape from the terrors of the French revolution—that social and political tempest in which the most illustrious were the first to suffer. Cast into prison upon the most absurd and groundless charges, the Lycée des Arts sent a députation of their number to him to assure him of the interest taken by that learned body in the preservation of a life so valuable to mankind; and to place upon his head a crown in token of the respect entertained towards the man who had rendered so many services to his country. Unfortunately, Lavoisier, besides being a man of eminent merit and of high connections, was a farmer of taxes, a class towards which the public enmity raged with extraordinary fury. Perceiving that his life was in danger, he sought refuge in a place prepared for him by M. Lucas, who had once been the doorkeeper at the Académie des Sciences; but hearing that twenty-eight of his associates had been consigned to the revolutionary dungeons, his generous nature was unwilling to prolong the danger to which he exposed his benefactors, and he voluntarily surrendered himself to the jailers.

In his prison Lavoisier continued those scientific

labours which had gained him so great a fame, although he was informed that he would be brought to trial in a few days. To be tried at that time was to be condemned. Lavoisier begged only a short delay in order that he might complete a few experiments and bequeath their results to the world; but the reply of the execrable Fouquier Tinville, the public prosecutor, was simply, "The republic has no need of chemists, nor of chemistry; the course of justice shall not be interrupted."

A few days later this great man perished by the guillotine. Lavoisier was a man of great generosity and benevolence. Only the year before the commencement of the revolution the town of Blois being threatened by a famine, he had placed a sum of fifty thousand francs at the disposal of the town without fixing any time for repayment. He was remarkable for his kindness to youthful genius, and took delight in assembling young students in his laboratory, many of whom subsequently became scarcely less famous than himself.

SIR CHARLES BELL, THE PHYSIOLOGIST.

SIR CHARLES BELL, whose discovery of the true functions of the nervous system is universally regarded as the most important contribution to physiological science since the demonstration of the circulation of the blood by Harvey, was a man of a remarkably humane and

kindly disposition. One day a young French medical student having been introduced to Sir Astley Cooper, to be present at an operation performed by the latter, the young man displayed an amount of nervousness hardly consistent with the surgical profession. Perceiving that Sir Astley observed his agitation, he apologized, lamenting that his nervous system would probably compel him to give up a study to which he was, nevertheless, ardently attached. "No, no," said Sir Astley, "you will recover from all that. Come; I will introduce you to Charles Bell, who will tell you how his courage failed him on his first attempt to bleed a patient." "Charles Bell," says M. Pichot, the relater of this anecdote, "received me with the same kindness; and, the story of the bleeding being mentioned to the great operator, he replied, 'Sir Astley has only spoken of my *first* experiment, but I will confess that if I had to repeat it to-morrow it would cost me almost as great an effort,' and he admitted that whenever he performed an operation, he had to contend with the same agitation."

Bell's great discovery was that the nerves of motion and the nerves of sensibility are common to all animals, but that the third, or superadded, division of nerves exists only where the organization requires more elevated functions. It was he alone who showed the method by which the brain communicates its will or impressions to the body, as well as how it receives impressions of pain or pleasure. His system was at first received with little favour, at least in this country. The most eminent in his profession ridiculed his suggestion that there were respiratory organs in the face, and that these were connected with expression. When Aber-

nethy had studied and acknowledged the truth of his system, he generously exclaimed, "What blockheads we have all been for not having thought of this grand and simple truth before!" In the dedication to his work on the nervous system, published in 1830, Bell says, "Whatever may be thought of the arguments adopted in this volume, the facts admit of no contradiction; and it may hereafter be a question of curiosity to know how they were received at first. The pleasure I enjoyed in my researches was great; the reception given to them by science has been contrary to what I expected. The first announcement of my work obtained not a single word of encouragement from the faculty. Some time later, when the publication of my papers by the Royal Society rendered it impossible to pass them by without notice, the interest they excited turned to the advantage of those who contradicted my discoveries, or pretended to have forestalled them;" and he adds, almost pathetically, "For myself this signifies little, but I confess my regret that the young students who have so favourably and zealously assisted me, in these researches should have been deceived in their hope of giving satisfaction to their profession."

"Continental surgeons, however, treated him with more generosity. It was in France that Bell received one of the noblest testimonies of homage, perhaps, ever rendered to scientific greatness. Being in Paris, he was desirous of hearing a surgical lecture of M. Roux, the eminent son-in-law of the surgeon Baron Boyer. Accordingly he attended the lecture-room of the Hôtel Dieu, the great Paris Hospital. Taking his seat among the young men, as he believed unnoticed, Bell

prepared to listen, but the Professor, who had enjoyed the hospitality of Bell in England, recognized his great contemporary, and having announced the fact to his audience, he dismissed them without a lecture, saying, with the energetic gesticulation peculiar to Frenchmen, "Gentlemen, enough for to-day. You have seen Charles Bell."

Bell was the son of a poor Scottish clergyman, a minister of the Episcopal Church, who performed the duties of a small curacy in Monteith with an annual stipend of twenty-five pounds, on which scanty pittance he brought up his three first sons. Charles Bell, like many other eminent men, was fortunate in possessing an excellent mother. "On the margin of a sketch of his career, published in a medical journal, a copy of which was found among his papers, he had written in pencil the following note, referring to a statement as to his early education: "Nonsense! I received no education but from my mother; neither reading, writing, ciphering, nor anything else. My education was the example set me by my brothers; there was in all the members of my family a reliance on self, and by imitation I obtained it. People prate about education, and put out of sight example, which is all in all."

Bell never attained the lucrative practice enjoyed by other eminent surgeons in London, and such good fortune as that of Sir Astley Cooper, who is stated to have earned in one year (1815) the enormous sum of twenty-one thousand pounds sterling, was beyond his dreams. His mind was almost incessantly occupied with anatomy, in which he found endless delight. He regarded his favourite study as something far greater than a mere

classification of the different parts of a body. In his journal for March, 1818, was found the note :—"I have solicited an interview with Rennie, the engineer, to discourse with him on the uses of anatomy, and to show him how the all-powerful Creator made arches, bridges, cables, and all that engineers undertake."

His most popular work is his 'Treatise on the Human Hand.' He died somewhat suddenly, of disease of the heart, at the seat of his friend, Mr. Holland, near Worcester, in 1842.

A PHILOSOPHER'S CHANGE OF NAME.

It is a curious circumstance that Cuvier, though always known by the Christian name of George, was not so baptized. George was the name of an elder brother who died shortly before the birth of the great scientific discoverer, who was a second son. Full of grief for the loss of her firstborn, Madame Cuvier had little hope of seeing even the new-comer arrive at manhood; for his feeble and sickly constitution demanded her incessant care. In after life the world-renowned naturalist cherished every circumstance connected with her memory; he delighted to recall her patient care and kindness, and to dwell upon things however trifling which reminded him of her. He liked to have about him the flowers which were her favourites, and whoever in his family circle was so thoughtful as to place a

bunch of red stocks in his study was sure to be rewarded with affectionate thanks. He had, indeed, many other reasons to remember her than his gratitude to a parent whose tenderness had snatched him from the perils of a sickly childhood; for it was she who had formed his mind, and trained him in those habits of thought and method which were so conspicuous in him in later years. He had been christened with the name of Leopold, but it appeared that in tender remembrance of her firstborn his mother would frequently call him George. The custom became confirmed with her: and when she died, Cuvier, out of respect for her memory, retained the name. Finally, after his marriage, it appearing that some difficulties might arise from his using a name that did not properly belong to him, he took the necessary steps for obtaining a legal right to it. Thus it was that Cuvier acquired the name of George.

“ A TERRIBLE INVENTOR.

In the year 1802 Lord Stanhope, the ingenious mechanician, called the attention of the House of Peers to some alarming rumours respecting the inventions of an American in France, with which country we were then at war. French writers had announced that ere long their ancient enemy would be astonished to see a flotilla of diving-bots which on a given signal would, to avoid

the pursuit of an enemy, plunge under water and rise again several leagues from the place where they descended. This, however, was not the most formidable item in the information which Lord Stauhope had obtained. This terrible American was stated to have invented, in conjunction with his diving-boats, an infernal machine which was to be silently and secretly carried under water, by means of one of these plungers, and attached with ease to the keels of the large men-of-war of the blockading squadron, who would find it impossible to be aware of the approach of their stealthy invader until a sudden and terrific explosion blew them in numberless fragments into the air. The inventor of these hitherto unheard of modes of warfare was Robert Fulton, a native of the United States, who had lived in England sometime, had been employed by the Duke of Bridgewater, and had been intimate with Watt, and other ingenious Englishmen. Finally, in 1803, an association of gentlemen was formed for the purpose of procuring information as to the progress of Fulton's designs, and as to what might be their consequences; and the result of the report of this association was so alarming, that Mr. Addington (afterwards Lord Sidmouth), then prime minister, opened a communication with Fulton, the object of which was to deprive France of the benefit of his inventions and services, and give England the advantage of them by inducing him to withdraw from France. Fulton, who was afterwards celebrated as the founder of the system of steam navigation in the United States, had commenced his experiments, with the authority of the Government of Napoleon, — then First Consul — at Brest, in the year 1801, and his

report to the French executive furnishes a curious account of his experiments:—

On July 3, in that year, he embarked with three companions on board his plunging boat in the harbour of Brest, and descended in it to the depth of twenty-five feet; but he did not attempt to go lower, because he found that his imperfect machine would not bear the pressure of a greater depth. He remained below the surface one hour; during which time they were in utter darkness. Afterwards, Fulton descended with candles, but finding a great disadvantage from their consumption of vital air, he caused previously to his next experiment, a small window of thick glass to be made near the bow of his boat, and he again descended on July 24, 1801. He found that he received from his window, or rather aperture covered with glass, for it was no more than an inch and a half in diameter, sufficient light to enable him to count the minutes on his watch. Having satisfied himself that he could have sufficient light when under water, that he could do without a supply of fresh air for a considerable time, and that he could descend any depth, and rise to the surface with facility; his next object was to try his boat's movements, as well on the surface as beneath it. On July 26, he weighed his anchor and hoisted his sails: his boat had one mast, a mainsail, and jib. There was only a light breeze, and therefore she did not move on the surface at more than the rate of two miles an hour; but it was found that she would tack and steer, and sail on a wind or before it, as well as any common sailing-boat. He then struck her mast and sails, to do which, and perfectly to prepare the boat for plunging, required about two minutes.

Having plunged to a certain depth, he placed two men at the engine, which was intended to give the vessel progressive motion, and one at the helm, while he, with a barometer before him, governed the machine, which kept her balanced between the upper and lower waters. He found that with the exertion of one hand only, he could keep at any depth he pleased. The propelling engine was then put in motion, and he found upon coming to the surface, that he had, in about seven minutes, made a progress of about five hundred yards. He then again plunged, turned his boat round while under water, and returned to near the place from which he began to move from. He repeated his experiments several days successively, until he became familiar with the operation of the machinery, and the movements of the boat; and he found that it was as obedient to her helm under water, as any boat could be on the surface; and that the magnetic needle traversed as well in the one situation as the other. On August 7, Fulton again descended with a store of atmospheric air compressed into a copper globe of a cubic foot capacity, into which two hundred atmospheres were forced. Thus prepared, he descended with three companions to the depth of about five feet. At the expiration of an hour and forty minutes, he began to take small supplies of pure air from his reservoir, and did so, as he found occasion for, four hours and twenty minutes; he then came to the surface, without having experienced any inconvenience from having been so long under water. Fulton was highly satisfied with the success of these experiments; it determined him to attempt to try the effect of these inventions on the English ships, which were then

blockading the coast of France, and were daily near the harbour of Brest.

Satisfied with the performance of his boat, which he called the "Nautilus," his next object was to make experiments with his torpedoes. A small shallop was accordingly anchored in the roads. Fulton approached to within two hundred yards of the anchored vessel, struck her with the torpedo, and blew her to atoms, a column of water and fragments being blown nearly a hundred feet into the air. This experiment was tried in the presence of Admiral Villaret and a multitude of spectators. Fulton now projected a larger boat upon an improved plan, and capacious enough to contain eight men, and with sufficient provisions for twenty days. This boat was intended to be of sufficient strength to enable him to plunge one hundred feet under water, and contained a reservoir stated to be sufficient to enable eight men to remain in that position for eight hours. When above water the boat had two sails and looked like an ordinary vessel; but when it was to dive the mast and sails were struck.

Throughout the summer of 1801, and till the project was relinquished on account of the season, Fulton appears to have been watching the English ships which were on the coast, little suspecting the singular kind of enemy prepared to take advantage of their movements. Fortunately for the English, or perhaps, for the sanguine inventor, though some of the British men-of-war daily approached the harbour, yet none came so near or anchored in such a situation as to be exposed to the effects of Fulton's preparation. In one instance, however, he came very near a British seventy-four gun

ship, which is stated to have made just in time such a change of position as to save herself. The French authorities appear soon after this to have become weary of the subject, and to have ceased to encourage Fulton; and it was ultimately against their own vessels that these machines were first tried. Tempted, it is said, by a reward secretly offered by the British Government, and probably irritated by the neglect of the French, he repaired to England, and on October 1, 1805, made an attack on the fleet of flat-bottomed boats assembled at Boulogne. He does not, however, appear to have used his diving-boat on this occasion, but only his torpedoes, which were thrown across the French vessels; but owing, as Fulton said, to a mistake in the throwing, they exploded alongside of the French vessels without doing them much injury. A few days later Fulton, in the presence of Mr. Gott and his colleague, blew up a strong-built Danish brig of the burden of two hundred tons, which had been anchored for the experiment in Walmer roads; but his inventions do not appear to have been put to any further trial.

FULTON AND THE EMPEROR NAPOLEON.

ONE of the most curious circumstances brought to light in connection with Fulton's experiments in France is the fact that in 1804, he actually offered to the Emperor, Napoleon to construct a steam-vessel, for one purpose

of conveying the Boulogne flotilla to England. . At first the Emperor appears to have looked favourably on the project, as appears from the following letter:—

“ I have just read the project of citizen Fulton, an engineer, which you sent me much too late, for it seems capable of changing the face of the world. At all events I desire that you will immediately place the examination of it in the hands of a committee, composed of members of the Institute, for it is to them that the scientific men of Europe will naturally look for a decision on the question. A great physical truth stands revealed before my eyes. It will be for these gentlemen to see it, and endeavour to avail themselves of it. As soon as the report is made it will be sent to you, and you will forward it to me. Let the decision be given in a week if possible, for I am impatient to hear it.

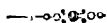
NAPOLEON.

“ 21st July, 1804.”

Napoleon, however, who was notoriously subject to sudden changes of determination in such matters, seems to have soon afterwards conceived a disgust for Fulton, probably on account of his recent failures. The scheme which might have had such momentous consequences was abandoned. The Emperor refused to permit the Academy of Sciences to investigate the subject; and when M. Louis Costaz, President of the Tribunal, spoke to him on behalf of Fulton, he interrupted him angrily with the words, “ There are in all the capitals of Europe a crowd of adventurers and projectors who run about offering to every government their pretended discoveries, which exist only in their imagination. They

are so many charlatans and impostors, who have no other view than to extort money. This American is one of the number. Speak to me no more about him." Yet this American only a few years later was the originator of a great and successful system of steam navigation in the United States, which preceded by some years the establishment of practical steam-vessels carrying passengers in any part of Europe.

PANORAMAS,



THE invention of panoramas, by which so real a character is given to representations of cities and landscapes, is due to Robert Barker, a portrait painter in Edinburgh, who obtained a patent for his invention in 1787. Five years afterwards he exhibited one in London, representing that city itself. The American, Fulton, who was more remarkable for his energy in carrying out the ideas of others than for originality of invention, introduced this new mode of painting into France about the year 1799, and was by the French generally supposed to be the inventor. In 1821, however, all previous attempts at panoramic drawing were thrown into the shade by the labours of Mr. Thomas Hornor, in making the sketches necessary for his great panorama of London. Mr. Hornor had been for some time engaged in executing drawings of landed estates in panoramic views. In the course of these pursuits he designed, and himself,

constructed, an apparatus by which the most distant scenery could be delineated with great accuracy. London and its environs furnished a good subject for a more extensive application of this ingenious instrument. Accordingly, when the cross of St. Paul's was taken down in 1821 to be repaired and regilt, Mr. Hornor availed himself of the circumstance to obtain permission to erect an observatory, supported by a slight platform several feet above the highest part of the present cross; and in this lonely and perilous position he fixed his apparatus, and, after many months, succeeded in producing on a large scale a series of drawings of the surrounding view, including even minute objects at a distance of many miles. The laborious toil which this enterprising young artist had to undergo in ascending the infinite staircases and ladders to reach his solitary habitation, independently of the danger of a journey so often repeated, did not damp his ardour. All possible precautions were taken for the prevention of accidents in his exposed situation; but the wooden box in which he passed so many hours, with its frail supports of poles and ropes, was in continual peril. The weather during the summer of 1821 was unfortunately more than usually boisterous. Scarcely a day passed without the derangement of some part of the scaffolding or the machinery connected with it; and so strong became the sense of danger arising from these repeated casualties, that notwithstanding offers of increased remuneration it was frequently impossible to obtain the assistance of workmen; a fact scarcely surprising when we learn that during the high winds no one could stand on the platform without clinging for support to the framework;

while the creaking and whistling of the timbers resembled those of a ship labouring in a storm, and the situation of the young artist was not unlike that of a mariner at the masthead.

During a squall, more than usually severe, a great part of the circular framework of heavy planks, erected above the gallery for the prevention of accidents, was carried over the house-tops to a considerable distance. At this moment a similar fate had nearly befallen the observatory, which was torn from its fastenings, turned partly over the edge of the platform, and its various contents thrown into utter confusion. The fury of the wind rendered the door impassable; and, after a short interval of suspense, an outlet was obtained by forcing a passage on the opposite side. By this misfortune, independently of personal inconvenience, considerable delay and expense were occasioned ere the work could be resumed; and it became necessary to provide against similar misfortunes, by securing the observatory to a cross-beam, and constructing a rope fence.

At other times the experiences of the artist were of a more agreeable character. "On entering the cathedral at three in the morning," says Mr. Hornor, in his interesting account of his impressions during his labour, "the stillness which prevailed in the streets of this populous city, contrasted with their mid-day bustle, was only surpassed by the more solemn and sepulchral stillness of the cathedral itself. But not less impressive was the development, at that early hour, of the immense scene from its lofty summit, whence was frequently beheld 'the Forest of London,' without any indication of animated existence. It was interesting to mark the

gradual symptoms of returning life, until the rising sun vivified the whole into activity, bustle, and business. On one occasion the night was passed in the observatory, for the purpose of meeting the first glimpse of day; but the cold was so intense as to preclude any wish to repeat the experiment."

During the work portions of the scene would sometimes be in bright sunshine, and at others in obscurity, producing an incessant alteration in light and shade. Many other difficulties presented themselves; but finally Mr. Horner surmounted them all, and succeeded in producing a complete panoramic view of the metropolis and its environs on 280 sheets of drawing paper, comprising a surface of 1680 square feet. The panorama of London, painted from these drawings, has long been familiar to London sightseers:

TELEGRAPHY UNDER DIFFICULTIES.

When the American statesman, Mr. Clay, was making a speech on the Mexican war at Lexington, in the far western state of Kentucky, in 1847, the "New York Herald" newspaper was anxious to obtain a report in advance of any other journal. For that purpose a reporter, when the speech was ready, took horse for Cincinnati, eighty miles distant, where a telegraph line had just been established. Horses had already been placed at every ten miles on the road. Over a rough,

hilly country, in the midst of wind and driving rain, the rider accomplished his journey in eight hours; but here a new difficulty was encountered. Scarcely had they begun the transmission of the speech when communication was suddenly interrupted, as if all the wires had been cut at the same moment. Not to be baffled, the man took horse again, and riding along the railway track in the dark and rainy night, he endeavoured to observe if any poles had been blown down. Nothing, however, met his notice for many miles, when the horse suddenly stumbled upon some obstacle, nearly throwing his rider. Lighting a pocket lantern which he had with him, he then discovered that the wires had been snapped asunder by the limb of a tree which had been blown down by the wind, and had fallen across them. To repair them temporarily with some wire which he had brought with him occupied but a short space, and riding back through the storm he found himself in time to transmit the remainder of the speech to New York for the newspaper of the next morning.

THE ROOF HAS FALLEN.



LADY HAWES has communicated to Mr. Beamish, the author of the Memoir of Sir M. I. Brunel, some interesting anecdotes of her father's judgment upon the strength of iron bridges and other buildings. One of these is eminently characteristic. Nearly forty years ago, when the application of cast-iron to these pur-

poses was much under discussion, Mr. Maudslay, whose great engineering talents Brunel was the first to discover, determined to exhibit his confidence in the material by erecting a cast-iron roof over his factory at Lambeth. Brunel, however, had contended that such structures would be insecure, unless well combined with ties of wrought-iron. So strongly had this opinion taken possession of his mind, that, when some one informed him in haste that a serious accident had occurred at his friend Maudslay's, he exclaimed anxiously, "The roof—the roof has fallen!" and, unhappily, this proved to be the case.

THE NATURAL PHILOSOPHER AND THE CAT.



I ONCE (says a French writer) saw a lecturer upon experimental philosophy place a cat under the glass receiver of an air-pump, for the purpose of demonstrating that life cannot be supported without air and respiration. The lecturer had already made several strokes with the piston, in order to exhaust the receiver of its air, when the cat, who began to feel herself very uncomfortable in the rarefied atmosphere, was fortunate enough to discover the source from whence her uneasiness proceeded. She placed her paw upon the hole through which the air escaped, and thus prevented any more from passing out of the receiver. All the exertions of the philosopher were now unavailing; in vain he drew the piston; the cat's paw effectually prevented

its operation. Hoping to effect his purpose, he again let air into the receiver, which, as soon as the cat perceived, she withdrew her paw from the aperture; but whenever he attempted to exhaust the receiver, she applied her paw, as before. The spectators clapped their hands in admiration of the cat's sagacity, and the lecturer was compelled to remove her, and substitute another cat who possessed less penetration for the cruel experiment.

STOPPED IN TIME.

ELIAB BERRITT, the "learned blacksmith," tells the following exciting story of how an entire train of passengers was saved from destruction by a timely message by telegraph. "During a storm and violent gale the long railway bridge across the Connecticut, between Hartford and Springfield, was lifted up by the wind, and thrown into the river beneath, two hundred yards in breadth, which a powerful current, at the time swelled to a dreadful height by an unusual flood of rain. The line here is crossed by a bridge fifty feet above the river, after an abrupt curve has been passed. But the passengers within congratulated themselves on their comfortable situations, thinking of the blessed homes and the friends which they soon expected to reach. On came the train, the engine blowing off its head of steam, breasting its way nobly against the gale, which almost threatened to check its progress, the hot iron hissing furiously in the falling rain. No one knew or even suspected that

the bridge was gone. For two years, by day and by night, the trains had passed and repassed, until safety had obliterated the thought of even the possibility of danger; but no bridge was there to receive them, and the long train with its precious freight rushed on towards the precipice of destruction. It was not customary to stop at this place, excepting to check the speed for the landing of passengers; but the people there had learned through the instrumentality of the telegraph, the loss of the bridge, and kept a sharp look-out for the approaching train. It came; the word was given, and they were safe. Every heart leapt from its place, and the head swam giddily with fear as the thought came of that fearful leap in the dark; and long will the passengers remember that dreadful road, and the friendly yet fearful cry of "THE BRIDGE IS GONE!"

A still more striking illustration of the important services frequently rendered by telegraphic communication is afforded by an instance related by Mr. Walker, the superintendent of the telegraphs of the South Eastern Railway Company. "On New Year's day, 1850," says this gentleman, "a collision had occurred to an empty train at Gravesend; and the driver having leaped from his engine, the latter started alone at full speed for London. Notice was immediately given by telegraph to London and other stations; and while the line was kept clear, an engine and other arrangements were prepared as a buttress to receive the runaway, while all connected with the station awaited in awful suspense the expected shock. The superintendent of the railway also started down the line on an engine, and on passing the runaway he reversed his engine and had it transferred

at the next crossing to the up-line, so as to be in the rear of the fugitive; he then started in chase, and on overtaking the other he ran into it at speed, and the driver of the engine took possession of the fugitive, and all danger was at an end. Twelve stations were passed in safety: it passed Woolwich at fifteen miles an hour; it was within a couple of miles of London when it was arrested. Had its approach been unknown, the mere money value of the damage it would have caused might have equalled the cost of the whole line of telegraph."

FARADAY'S FIRST PATRONS.

PROFESSOR FARADAY, in a letter written to Dr. Paris, tells the following pleasing anecdote of how he came to devote himself to the science of chemistry, in which he has since become so celebrated:—"When I was a bookseller's apprentice," he says, "I was very fond of experiment, and very averse to trade. It happened that a gentleman, a member of the Royal Institution, took me to hear some of Sir Humphrey Davy's last lectures in Albemarle Street. I took notes, and afterwards wrote them out more fairly in a quarto volume. My desire to escape from trade, which I thought vicious and selfish, and to enter the service of science, which I imagined made its pursuers amiable and liberal, induced me at last to take the bold step of writing to Sir Humphrey Davy, expressing my wishes and a hope that, if an opportunity came in his way, he would favour my views, and at the same time I sent the notes I had taken of his lectures."

Sir Humphrey was at once struck, not only with the proof which the notes of his lectures afforded of the diligence of his young and unknown correspondent, but also with the knowledge which they displayed, for it would, of course, be impossible for one ignorant of chemical science to report correctly a lecture on the subject. In a few days the bookseller's apprentice, to his great delight, received the following reply:—

“December 24, 1812.

“Sir,—I am far from displeased with the proof you have given me of your confidence, and which displays great zeal, power of memory, and attention. I am obliged to go out of town till the end of January. I will then see you any time you wish. It would gratify me to be of any service to you. I wish it may be in my power. I am, sir, your obedient, humble servant,

“HUMPHREY DAVY.”

Sir Humphrey kept his word. Early in 1813, Michael Faraday received a message from him, and with a joyful heart he repaired to Sir Humphrey's house in Albemarle Street. The humble appointment of assistant in the laboratory of the Royal Institution happened to be vacant, and Sir Humphrey promised to support his visitor in an application for it. The application was successful, and a few months later the young chemist went abroad with his patron and Lady Davy, acting as Sir Humphrey's amanuensis and assistant in experiments. In 1815 he returned to his duties in the laboratory of that institution, which has been the scene of his great scientific labours, and where he still continues. Ultimately Mr. Faraday became Fullerian Professor,

while his investigations into the relations of heat, light, magnetism, and electricity have resulted in discourses of the utmost importance to science, and have contributed to make his name known throughout Europe.

Mr. Faraday is a man of humble origin, the son of a poor blacksmith. He was apprenticed to a bookseller, or rather to a bookbinder, or one who obtained a living by purchasing cheap sheets of books and binding them up for retail sale. This bookseller and bookbinder, whose name was Tiebau, first called the attention of one of his customers, Mr. Dance of Manchester Street, to an electrical machine and some other philosophical apparatus, the work of his apprentice; and it was Mr. Dance, the "Member of the Royal Institution," referred to in Mr. Faraday's letter, who introduced the young man to that institution, where, his being fortunate enough to hear the four last lectures ever given there by Sir Humphrey, laid the foundation of his future fame.

A SUBMARINE SURVEY.

WHEN the question was first raised of whether a telegraphic wire could be laid on the bottom of the Atlantic, every care was taken to bring together all the evidence that could be gleaned of the actual character of the vast oceanic basin which was to be the scene of the great enterprise, and to compare them with the labours of Captain Maury, who had already demonstrated the existence of a great Atlantic plain. This plain, according

to Maury, was scarcely twelve thousand feet below the level of the sea, and extended in a continuous ledge from Cape Race, in Newfoundland, to Cape Clear, in Ireland. Its greatest depth was declared to be in mid-ocean, whence it imperceptibly ascended to the shore on either side. In order to verify the theory of such a plateau, the Atlantic Telegraph Company, aided by the Governments of Great Britain and the United States, caused surveys to be made, and the knowledge thus obtained was conclusive. The plain was found to be gently levelled, so deep as to be below the reach of disturbing superficial causes and composed of particles of shells, so minutely broken up as to render their character undetectable save with the aid of a microscope. Their presence, examined by the lights of science, proved how little these profound depths had been disturbed in the course of uncounted ages, and greatly encouraged the hope that the Atlantic cable, when once laid along with them, might rest as tranquilly—perhaps as long. The tendency of these infinitesimal fragments to stick to any metallic centre exposed to them, held out the expectation that the submerged cable would soon be thickly enveloped by them, and a fresh element of security so obtained.

This submarine plateau is really a gently-levelled plain, lying just so deep as to be inaccessible to the anchors of ships, and to other sources of surface interference, and yet not so far depressed but that it can be reached by mechanical ingenuity without any very extravagant effort. It seems, indeed, that it is a portion of a great zone of table-land which entirely encircles the earth, or which, at least, stretches from the western side of America to the Asiatic coast of the Pacific.

A STORM IN A TELEGRAPH OFFICE.

ONE afternoon, some years ago, during a heavy fall of rain, the bells of the electric telegraph, placed in a small office at one end of the St. Germain's Atmospheric Railway, suddenly began to ring, which led the attendant to suppose that he was about to receive a message. Several letters then made their appearance, but no sense could be made of them, and he was about to make the signal "Not understood," when suddenly he heard an explosion, similar to a loud pistol shot, and at the same time a vivid flash of light was seen to run along the conductors placed against the sides of the shed. The conductors were broken into fragments which were so hot as to scorch the wooden tables on which they fell, and their edges presented evident traces of fusion. The wires of the electro-magnets, belonging to the apparatus placed in the office, were also broken, and at the same instant the attendant experienced a violent concussion, which shook his whole frame. The little office was connected with the Paris station by wires supported on posts; yet at Paris nothing remarkable occurred, except that several of the bells were heard to ring. But at a short distance from the shed, the top of one of the posts which support the wire was split; and where the wires were bent at the corners of the angles, three sharp points of light were observed several seconds after the explosion.

At the time of the explosion, an attendant, who was holding a handle which moves a needle at a short

INVENTION AND DISCOVERY.

distance from the extremity of the railway, also sustained a violent concussion, and several workmen standing about him experienced severe shocks.

This story is told by Monsieur Arago, the great astronomer, in a letter to M. Braguet, who was of opinion that the explosion came from the railway, for, on account of the immense quantity of metal employed in its construction and the extent of its surface, it was probable that, during a thunder-storm, it would be the seat of an intense electric tension, and that the fluid thus attracted would discharge itself on the telegraphic wires, which were near the iron rails, tubes, and needles.

THE DISCOVERER OF CALIFORNIAN GOLD

WHEN the Swiss Guard upon which Charles X had relied so unwisely for the maintenance of his arbitrary government were dispersed by the revolution of 1830, a certain Captain Sutter, who had served in that body, determined to quit the country in which he and his comrades were so unpopular, and to seek his fortune in a new capacity in the far wilds of North America. A Swiss by birth, Sutter possessed all the industry and persevering energy peculiar to his countrymen. Ready to serve as a soldier where moderately good pay and a commission were offered to him, he was equally ready to clear a space in the primeval forest, or to build himself a home on the prairie. Accordingly in 1830 he set

sail from Havre for New York, whence in a short time he proceeded to the far-western state of Missouri. Here having acquired a little money by agriculture, he removed at the end of six years to the still more remote territory of Oregon, and finally, in 1839, he settled in California.

This country was then but little known, with the exception of the seaboard, where vessels from all parts traded with the Indians chiefly for skins; but the Swiss captain belonged to a class who can contrive to prosper anywhere. Far beyond the limits of civilized life he determined to lead an independent existence, and to become a sort of sovereign, on a small scale, of the wild country around him. Accordingly, he built with the aid of his men a fort on the River Sacramento, a very necessary protection from hostile tribes of Indians. This fort he named after his native country, New Helvetia; and in the prairie round this spot he gradually accumulated a herd of four thousand oxen, besides fifteen hundred horses and mules, and two thousand sheep. He also became the owner of a vast acreage of land under grain crops, and of two trading vessels in the river. His fort was supplied with twelve pieces of artillery, and defended by a garrison of seventy men, and its owner was beyond all question the wealthiest and most independent man in the vast range of country between the Rocky Mountains and the Pacific Ocean.

It was in September, 1847, that Captain Sutter, being anxious to construct a saw mill to be turned by water power, near a pine forest, employed for the purpose a friend skilled in engineering and in all the work progressed, and the supply of

mill was so situated as to wash down a great deal of mud and gravel from the higher land, passed through by the stream. Loitering by the side of the new mill one day, while the works were in progress, Mr. Marshall was struck by some glittering particles in this sand, and taking a portion away with him in a bottle he determined to show it to his enterprising employer.

"What are those bright grains?" asked the engineer, as he held up the bottle in the sun before his friend's eyes.

The Swiss eyed them attentively for some time, and then replied, "Gold. But where did this come from?"

"From yonder," replied Marshall, taking his companion to the door, and pointing to the range of hills clothed with pine trees in the distance: "if these glittering specks are gold, as I believe they are, there is wealth in those regions beside which all your flocks and herds will be a trifle."

"It is, gold beyond doubt," replied the captain; "and this is how gold is generally found; but this sand is rich beyond example. We must keep this secret, and become gold-diggers together."

The precious secret was kept for a short time, and the captain and his friend found means to gather abundant proofs of the productiveness of the region in the precious metal; but it soon became whispered abroad that gold had been discovered at the American fork of the Sacramento River; and to the astonishment of the world a gold fever arose, such as had never been known before. A few labourers became possessed of some of the precious dust, and took it for sale to San Francisco, the town at the mouth of the Sacramento.

The news spread with the rapidity of a fire amidst the withered grass of the prairies. Soldiers and sailors deserted for the "diggings;" shopkeepers closed their shops; and fled to the same attractive region; and in a few months the solitudes in which the flocks and herds of the ex-captain of the Swiss Guard had lately wandered at will were filled with a motley gathering, whose labours quickly became a subject of intense anxiety in every money market in the Old and New World.

THE VICISSITUDES OF GAS-LIGHTING.

MORE than one hundred and thirty years ago a writer in the "Philosophical Transactions," in a narrative of the sinking of a coal-pit, belonging to Sir James Lowther, near Whitehaven, described, with remarkable minuteness and precision the principal properties of coal-gas. A jet of natural gas had been discovered by the workmen issuing from the coal-seams at the side of the pit. By means of a funnel, the writer tells us, that he found it easy to fill a bladder in a few seconds; and he adds, "The bladder being tied close may be carried away and kept some days, and being afterwards pressed gently through a small pipe into the flame of a candle, will take fire and burn at the end of the pipe as long as the bladder is gently pressed to feed the flame, and when taken from the candle, after it is so lighted, it will continue burning till there is no more air left in the bladder to supply the flame." These facts, it appears, were de-

monstrated before the Royal Society in May 1733, when the gas was found to give a brilliant flame after it had been confined in the bladder nearly a month. Six years later Dr. John Clayton describes, in the same journal, how he has actually manufactured this gas, or "spirit of coal," as he calls it, from pieces of coal placed in a retort, and how he had been in the habit of preserving it in bladders and diverting his friends by illuminating his room with jets of gas obtained by these means. Thus was the principle of gas-lighting fully developed; but more than eighty years later the streets of our cities were still lighted—if lighted it could be called—by the feebly glimmering oil lamps which many persons yet remember.

In 1767 the subject engaged the attention of Dr. Richard Watson (afterwards Bishop of Llandaff), who published the result of his researches. His experiments show that he had examined the products arising from the distillation of pit coal with great care. The publication of these experiments excited others to apply themselves to the subject in the coal districts of various parts of the kingdom, for the purpose of extracting the tar. In the year 1784, a Mr. Diller exhibited, in London and other large towns, what he called, "Philosophical Fireworks," which were produced by the combustion of the inflammable gases, and "they were deemed great curiosities. All these experiments, however, can hardly be considered as practical. It is to Mr. Murdoch of Soho, near Birmingham, the intimate friend and fellow-worker of Watt and Boulton, that we are indebted for the first application of gas to house-lighting. It was this ingenious gentleman who first exhibited the mode

in which it might be employed, instead of lamps or candles, for all the usual purposes of artificial lighting. While staying at Redruth in Cornwall, Mr. Murdoch made gas from numerous substances. He lighted his house, and also a street lamp, and had bladders filled with gas to carry at night, with which he astonished the country folks. Finally, in 1798 he constructed an apparatus at Soho, which enabled him to exhibit his plan on a far larger scale; and the Peace of 1802 afforded him an opportunity for a great display of these brilliant lights. The illumination of the Soho works on that occasion was one of extraordinary splendour. "The whole front of that extensive range of building," says one who was present, "was ornamented with a great variety of devices, which admirably displayed many of the various forms of which gaslight is susceptible. The spectacle was as novel as it was astonishing, and Birmingham poured forth its numerous population to gaze at and admire this wonderful display of the effects of science and art."

One of the most industrious and useful of the pioneers of gas lighting was Mr. Winsor, who had the undoubted merit of first lighting a street with coal gas on a system which, defective as it was, was an immense advance upon the old oil-lamp. Winsor was one of those busy sanguine men who frequently make up for want of knowledge by their perseverance in carrying a favourite point. Although he obtained a patent in 1802 for certain improvements in gas lights, he can scarcely lay claim to the character of an inventor or discoverer. He possessed scarcely any knowledge of chemistry, and was so deficient in mechanical information that it is stated

he was unable to give proper directions for the construction of his apparatus. He is believed to have obtained his notions from a Frenchman named Le Bon, who, acting upon the ideas disseminated by Murdoch, had lighted up his house and gardens in Paris in 1801 with gas obtained from wood and coal, and had contemplated lighting up the city of Paris by the same means. Winsor, who was a German, returned to England immediately after this, and in 1803 and 1804 publicly exhibited his plan of illumination by coal-gas at the Lyceum Theatre in London. Here he delivered lectures on the subject, which he illustrated by a number of experiments. Among others, he showed the manner of conveying the gas from one part of a house to another; and, by the use of different kinds of burners, he was enabled to display something of that variety of forms which may be given to its flame. Winsor's exhibitions were eminently useful, and tended, in a high degree, to turn public attention to gas-lighting. While he was engaged in exhibiting and lecturing at the Lyceum, he was occasionally subject to great vexations. It is related that he was so unfortunate as to select for his assistants such men as were remarkable for their ignorance rather than for ability or skill, and that scarcely any dependence could be placed upon their attention or diligence. He was also sometimes exposed to their impositions, and being a foreigner, he was under the necessity of engaging a person to read his lectures to his audience. Sometimes, too, when the auditors were assembled his reader failed to appear, and probably had the manuscript lecture in his pocket; and of course they were obliged to retire disappointed and disgusted. The character of

his mechanical assistants was much the same; and they were generally such as to be incapable of rendering him any effective service in his pursuits. These and other mortifying circumstances engaged him in frequent altercations; and he bitterly complains of these disastrous occurrences in his pamphlets. His gas, too, from being burnt in a very impure state, was offensive to the smell, which greatly annoyed his audience; and these circumstances tended to produce a dislike to gas-lighting.

There is no doubt that Winsor's great pretensions also tended to prejudice the public. He was much given to boasting, and he told the world that, by a deposit of five pounds for a share in his National Light and Heat Company, a person might secure a handsome annual income. "All gas-lights," he says in one of his boastful but curious and characteristic addresses to the public, "exhibited before my illuminating the large theatre in the Lyceum early in 1804, I fairly consider as so many Will-o'-the-wisp lights, known for centuries past. The gas of these lights has been caught and collected in bladders, in marshy ground, the same as all coal-gas has hitherto been produced in bladders for philosophical amusement. The principle, that coal and other combustibles contained, among other products, a most beautiful and valuable flame, has been known by the most learned of the last century; but how to make application—how to save and analyze—how to preserve and refine—how to conduct gas in proper air-tight tubes—how to introduce gas-fire and gas-lights into a drawing-room, shop, and street-lamp—how to cook, melt, boil, and distil by a gas-fire, either in a kitchen

er dining-room—how to introduce coke, tar, and ammoniacal liquor for the advantage of a whole nation—how to make gas-fire and gas-lights applicable to light-houses, telegraphs, and culinary purposes—in fine, how to save and employ all the valuable parts of raw fuel with the greatest possible advantage;—all these most difficult points of my discovery were left a problem to theorists, who could write, but not practise—who could fill bladders from retorts, tobacco-pipes, pots, pans, and gun-barrels with raw smoke, but could not illuminate—whose delicate hands and noses would have shrunk with horror from my numerous dirty and laborious experiments in kitchens and wash-houses, where my own labourers complained of being suffocated, and often refused to assist me, until I shamed them by the example of stripping to perform what they thought was too dirty work for them.” And he continues in the following magniloquent strain:—“Animated by the life and example of Peter the Great, emperor of all the Russias, who performed the most abject labours to teach his ministers and generals how to civilize a barbarous nation, I did no longer deem it beneath me (who had been a new-hant in the city of London) to do that work which some of my labourers, actually in want of bread, refused to do for victuals and payment.”

Notwithstanding these high pretensions, it does not appear that Mr. Winsor ever thought of a plan for storing gas in anything except the main-pipes. In 1807, however, he removed his exhibitions to Pall Mall, and lighted up a part of one side of that street, which was the first instance of this kind of light being applied to such a purpose in London. This practical demonstra-

tion of the practicability of his schemes was of great value in calling further attention to the subject, although the shareholders in the National Light and Heat Company reaped no benefit, and the practical art of making and supplying gas had still many steps to make; but, thanks to the valuable scientific labours of Dr. Henry, and to the practical experiments of Mr. Clegg, a pupil of Boulton and Watt, the cause of coal-gas lighting finally triumphed over all obstacles, including the claims of its rival "oil-gas," which, even as late as 1825, was still preferred by powerful supporters. A charter was granted in 1812 to the company known as the Chartered Gas Company, which was a kind of resuscitation of Mr. Winsor's association; and, in 1816, this company extended mains from their works in the Curtain Road into the City. The opposition to this company was very great. The chief chemists of the day, including Davy and Wollaston, maintained that coal-gas never could be safely applied to street lighting; and Sir Humphrey Davy inquired, ironically, "if it was intended to take the dome of St. Paul's for a gasometer."

From this time, gas-lighting began to extend itself, and, in the course of the following ten years, it had almost entirely superseded the old systems: but the manufacture was still extremely rude. Some terrible accidents in the Chartered Company's Works alarmed the public, and the process was closely watched by Government inspectors. Sir William Congreve, who made a report to Parliament on the subject in 1822, states that he saw two large canvas bags in some works at Whitechapel of about fifteen thousand cubic feet

each, which were for some time used as gas-holders, and lay in close proximity to a blacksmith's forge; and he pointed out the frightful consequences which might ensue "were the tar to be discharged and inflamed, like the emission of a large quantity of burning lava from an artificial volcano." The dread in which the public long regarded the gas companies, and the general tendency to interfere with their operations, could not be better exemplified than by the fact, that a deputation from the Royal Society, headed by Sir Joseph Banks, having visited the gas works of the Chartered Society at Westminster, they strongly recommended the Government to forbid the company constructing gas holders exceeding six thousand cubic feet in capacity, which were to be confined in very strong buildings. Gas-holders are now constructed in the open air, in the midst of the metropolis, made to hold from a quarter of a million to half a million of cubic feet each. Mr. Hollingshead in his work, entitled "Underground London," says "we have now, within the metropolitan area, twenty-three gas manufacturing stations, and six gas-holder stations, used solely for storing gas. The total length of mains laid down by the thirteen companies, in underground London, is seventeen hundred and fifty miles, besides about four hundred and fifty miles of branch service pipes. The house service-pipes, in addition to this, must be at least eight thousand miles long. The total number of London public street lamps supplied with gas is thirty-seven thousand seven hundred and twenty-eight, the average distance from each other being seventy-five yards. The consumption of gas is at least double what it was

ten years ago; and the annual quantity manufactured in London is about eight thousand millions of cubic feet."

TUNNELLING UNDER THE THAMES.

FIFTEEN years before the commencement of the present Thames Tunnel, Trevithick, the Cornish miner, began an attempt at tunnelling under the River Thames. The idea was not new; for a still more daring experiment had been commenced by an engineer named Ralph Dodd, whose scheme was nothing less than the construction of a tunnel or "archway," under the Thames, from Gravesend to Tilbury, where the breadth of the river is of course far greater than nearer to London. Trevithick, aided by Vasey, another Cornish man, having raised subscriptions, began boring at Rotherhithe; and in order to save expence kept very near to the bottom of the river. Notwithstanding this, his attempt was astonishingly successful, for he actually carried his tunnel a distance of nearly 231 yards, or within thirty-three yards of the entire length proposed to be bored. A surveyor was appointed to report on the progress of the work on behalf of the capitalists who supported it, and unfortunately a dispute arose at this point between Trevithick and this gentleman. The surveyor asserting that the tunnel had run one or two feet out of the direct line, Trevithick is said to have displayed the proverbial irritation of Cornish men. Resolved not to put up with this slur upon his skill as an engineer,

he determined on the ridiculous expedient of actually making a hole in the roof of his tunnel at low water, and thrusting through a series of rods which he continually lengthened, like the joints of a fishing-rod, which were to be received by a man in a boat, and then observed from the shore. This device proved the ruin of the work. In fitting the rods delays occurred, until suddenly so much water was found to be making its way through the hole, that it became necessary for the engineer and his workmen to retreat. It is related that Trevithick, when the imminent danger became apparent, refused to be the first to leave the works. He sent his men away first, and his life nearly fell a sacrifice to his devotion. Owing to the tunnel following the curve of the bed of the river, the water had congregated towards one point, a fact which, in the confusion of the moment, had not been foreseen; and by the time Trevithick reached the light, the water had actually risen to his neck. Thus by an act of extraordinary imprudence the Cornish engineer's great undertaking came to an end almost at the point of complete success.

The present Thames Tunnel was planned by Brunel in 1823, and in 1824 a company was formed to carry out the work. The simple observation of the habits of a seaworm, known as the *Teredo navalis*, which, in boring into the timbers of a ship, contrives to render the sides of its perforation waterproof by means of a chalky secretion from its own body, suggested to the engineer the idea of his famous "shield." This cast-iron apparatus contained thirty-six cells, in each of which was an excavator, who cut out the earth, while a bricklayer built up from the back of the cell a brick arch, which was pressed for-

ward by screws. But the first step was to sink a brickwork shaft already built, fifty feet in diameter, and forty-two in height, into the ground at 150 feet from the Rotherhithe side of the river. This gigantic labour was accomplished by a powerful steam engine, which raised the earth and drained the water from within; while the brickwork cylinder, which was calculated to weigh one thousand tons, was sunk into the ground. The horizontal tunnel was then commenced from near the bottom of the cylinder, at the depth of sixty-three feet from the surface.

The difficulties and dangers encountered in the progress of this work, the frequent breakings in of the water, the suspension and subsequent recommencement of the undertaking, and its final successful completion, for a long time supplied the public with topics of excitement. Sometimes parts of the shield gave way with a noise which resounded through the partly-formed tunnel like a discharge of artillery; then came explosions of gases, momentarily illuminating the darkness with sheets of flame, and rendering the workmen insensible.

The roadway was begun on New Year's day, 1826, and upwards of 540 feet had been safely excavated, when on the 18th of May the river burst in. With indomitable patience the engineers filled the aperture with an enormous number of bags of clay sunk in the river, pumped the water out of the tunnel, and resumed the work. Scarcely had they proceeded 150 feet further when the dreaded water again broke in and six men were drowned. The shareholders were now disheartened, but not so the engineers. After a long sus-

pension of the works, a public subscription and a loan from Parliament enabled them to resume them. On the 25th of March, 1843, the tunnel was finally opened to the public.

Many interesting anecdotes are told in connection with the work. A few days previous to the first contest of the bed of the river with the soil, the feed-pipe of one of the boilers of the steam-engine burst. To stop the pumps might have been attended with considerable inconvenience, if not danger. As it chanced, Brunel and his able coadjutor, Mr. Beamish, were on the top of the shaft. Alive to every unusual sound, they ran to the engine-house. Brunel at once perceived the nature of the accident. Seizing some packing and a piece of timber, he jumped upon the boiler, and with wonderful presence of mind applied the packing to the fissure, and one end of the quartering upon that—jamming the other end against the slanting roof of the building. Finding now that the roof was being actually raised, he elapsed the quartering, and there hung, like the weight on the safety-valve, until his companion was able to procure sufficient weight to attach to the timber, and relieve him from his perilous situation. By this happy expedient time was fortunately gained, the other boiler was filled, and the steam-engine continued its uninterrupted work.

The following vivid account of one of the irruptions of the river is also given by Mr. Beamish, who was present near the shield under the bed of the river at the time of the accident:—"The miner, Goodwin," he says, "a powerful and experienced man, called for help. For him to have required help was sufficient to indicate danger. I immediately directed an equally powerful

man, Rogers, to go to Goodwin's assistance; but before he had time to obey the order, there poured in such an overwhelming flood of slush and water that they were both driven out; and a bricklayer, who had also answered to the call for help, was literally rolled over on to the stage behind the frames as though he had come through a mill-sludge, and would have been hurled to the ground if I had not fortunately arrested his progress. I then made an effort to re-enter the frames, calling upon the miners to follow; but I was only answered by a roar of water, which long continued to resound in my ears. Finding that no gravel appeared, I saw that the case was hopeless. To get all the men out of the shield was now my anxiety. This accomplished, I stood for a moment on the stage, unwilling to fly, yet incapable to resist the torrent which momentarily increased in magnitude and velocity, till Rogers, who alone remained, kindly drew me by the arm, and pointing to the rising water beneath, showed only too plainly the folly of delay. Then ordering Rogers to the ladder, I slowly followed.

"As I descended from the stage, the water had so risen in the tunnel that all the loose timber near the frames, the cement boxes, and the large boxes used for mixing the cement, were not only afloat, but in considerable agitation. The light was but barely sufficient to allow me to grope a way through these obstructions, which, striking against my legs, threatened seriously to arrest my progress. I felt that a false step could not be retrieved, clad as I was, and with heavy boots quite full of water. After a short struggle I succeeded in gaining the west arch, which, having been appropriated to visitors, was comparatively free. The water was per-

ceptibly rising; it had already reached my waist; still I could not venture to run, feeling that a stumble might yet prove fatal. If I could only gain the barrier which limited the ingress of visitors, I should be clear of the floating timber which must be there arrested. As I approached this barrier, the sight of some of our most valued hands cheered me. Not understanding the cause of procrastination, they could not withhold their expressions of impatience. Arrived at the barrier, four powerful hands seized me, and in a moment placed me on the other side. Or we now sped. At the bottom of the shaft we met Isambard Brunel and Mr Gravatt. We turned. The spectacle which presented itself will not readily be forgotten. The water came on in a great wave, everything on its surface becoming the more distinctly visible as the light from the gas lamps was more strongly reflected. Presently a loud crash was heard. A small office which had been erected under the arch, about a hundred feet from the frames, had burst. The pent air rushed out; the lights were suddenly extinguished; and the noble work, which only a few short hours before had commanded the homage of an admiring public, was consigned to darkness and solitude.

"It only remained to ascend the shaft, but this was not so easy. The men filled the staircase; being themselves out of danger, they entirely forgot the situation of their comrades below. For the first time I now felt something like fear, as I dreaded the recoil of the wave from the circular wall of the shaft, which, if it had caught us, would inevitably have swept us back under the arch. With the utmost difficulty the lowest flight of steps was cleared, when, as I had apprehended, the

recoil came, and the water surged just under our feet. The men now hurried up the stairs, and though nearly exhausted, I was enabled to reach the top, where a new cause of anxiety awaited us. A hundred voices shouted, 'A rope! a rope! save him! save him!' How any one could have been left behind puzzled and pained me sorely. That some one was in the water was certain. With that promptitude which ever distinguished Isambard Branel, he did not hesitate a moment. Seizing a rope, and followed by Mr. Gravatt, he slid down one of the iron ties of the shaft. The rope was quickly passed round the waist of the struggler, who proved to be old Tillet, the engineman. He had gone to the bottom of the shaft to look after the pumps, and being caught by the water was forced to the surface, from which he would speedily have disappeared; but for the presence of mind and chivalrous spirit of his officers.

"The roll was now called, when, to our unspeakable joy, every man answered to his name; and we were thus relieved from the painful retrospect that must have followed any sacrifice of life."

Frequent troubles were experienced from the use of the diving-bell. Links in the chain by which it was suspended gave way, and occasionally vessels in the crowded river ran foul of the bell barge, sending it adrift. Underground imaginary alarms frequently added to the troubles of the miners. One of these was of a somewhat ludicrous character. Besides the watch in the tunnel, it was customary to place a watchman at the entrance, near the "weir," by which the quantity of water coming from the working was measured; and one Saturday night this important

duty was assigned to the faithful Rogers. Suddenly at about three o'clock in the morning he was startled by the terrible words, issuing in a loud tone from the tunnel, of "Wedges! clay! oakum! The whole of the faces coming in. Coming altogether." Recognizing the voice of Fitzgerald, the foreman bricklayer, one of the watch, Rogers himself gathered together some wedges and timber, and made his way to the frames, expecting to find there all terror and confusion; but he saw nothing strange, and could hear nothing more ominous than the customary sound of pumping. He then examined every top bar where it was the duty of the men to keep watch, but there was no appearance of any movement. The idea flashed across his mind that all had been drowned, when, to his astonishment and relief on mounting a stage near the west arch, he found the whole of the watchmen comfortably asleep on clean straw. Fitzgerald, who was of the number, had been naturally dreaming of the dangers which were ever about them day and night, and the exclamations which had caused so much alarm had been uttered by him in this condition, and re-echoed through the tunnel till they reached his brother watchmen.

The total cost of the Thames Tunnel was about £154,000. As a commercial speculation it was entirely unsuccessful; the carriage descents were never completed; the foot-passenger traffic has never been sufficient to yield any considerable profit; and at this moment it is in contemplation to convert this extraordinary work into a tunnel for a railway.

THE IDEA OF THE THAUMATROPE.

ACCORDING to a story in Mr. Babbage's interesting "Passages from the Life of a Philosopher," the idea of this beautiful philosophical toy is due to the astronomer Herschel and his friend Dr. Fitton. "One day," says Mr. Babbage, "Herschel, sitting with me after dinner, amusing himself by spinning a pear upon the table, suddenly asked whether I could show him the two sides of a shilling at the same moment.

"I took out of my pocket a shilling, and holding it up before the looking-glass, pointed out my method. 'No,' said my friend, 'that won't do;' then spinning my shilling upon the table, he pointed out his method of seeing both sides at once. The next day I mentioned the anecdote to the late Dr. Fitton, who a few days after brought me a beautiful illustration of the principle. It consisted of a round disc of card suspended between the two pieces of sewing silk. These threads being held between the finger and thumb of each hand, were then made to turn quickly, when the disc of card, of course, revolved also.

"Upon one side of this disc of card was painted a bird; upon the other side, an empty bird-cage. On turning the thread rapidly, the bird appeared to have got inside the cage. We soon made numerous applications, as a rat on one side and a trap upon the other, etc. It was shown to Captain Kater, Dr. Wollaston, and many of our friends, and was, after the lapse of a short time, forgotten.

“Some months after, during dinner at the Royal Society Club, Sir Joseph Banks being in the chair, I heard Mr. Barrow, then Secretary to the Admiralty, talking very loudly about a wonderful invention of Dr. Paris, the object of which I could not quite understand. It was called the thaumatrope, and was said to be sold at the Royal Institution, in Albemarle Street. Suspecting that it had some connection with our unnamed toy, I went the next morning and purchased, for seven shillings and sixpence, a thaumatrope, which I afterwards sent down to Slough to the late Lady Herschell. It was precisely the thing which her son and Dr. Fitton had contributed to invent, which amused all their friends for a time and had then been forgotten. There was, however, one additional thaumatrope made afterwards. It consisted of the usual disc of paper. On one side was represented a thaumatrope (the design upon it being a penny-piece), with the motto, ‘How to turn a penny.’ On the other side was a gentleman in black, with his hands held out in the act of spinning a thaumatrope, the motto being, ‘A new trick from Paris.’”

THE PIANOFORTE.



THE introduction into this country of the pianoforte—that favourite instrument which is now found in every household where a taste for music exists—may almost be said to have taken place within the memory of living persons. As early as 1716 an inventor, named Marius,

presented to the Academy of Sciences in Paris a clavecin, whose strings were vibrated with hammers instead of plectrums; and two years later, Christoforo, a Florentine musical-instrument maker, devised some further improvements on the instrument. This has generally been considered as the first piano. In 1760 a foreigner, named Zumpe, established in England a small manufactory of these instruments; but he met with little success. Its merits were, however, clearly perceived by Haydn, who left sixty sonatas composed expressly for it; Gluck also adopted the new invention, and the piano on which he composed his "Armida," and other works, made for him by John Pohlman in 1772, still exists. It is stated to be only $4\frac{1}{2}$ feet in length, and 2 feet in width, with a small square sounding-board at the end, the wire of the strings being little more than threads, and the hammers consisting of a few piles of leather over the end of a horizontal jack working on a hinge. "The instrument," says M. Thalberg, "compared with a fine piano of the present day, is utterly insignificant and useless; and it is difficult to conceive how it could have been used for the purposes it certainly served, till we reflect upon the importance to the composer of having at instant command any description of orchestral effect."

In France the first maker of a pianoforte was Sebastian Erard, who died in Paris in 1831. Erard was the orphan child of a cabinet-maker in Strasbourg. He came to Paris when only sixteen years of age, and apprenticed himself to a harpsichord maker, in whose employment his ingenious mind soon found means to display itself. His apprenticeship being ended, the

young Strasbourg workman obtained employment from various instrument-makers, which he executed at his own house. One day a harpsichord-maker, struck by his talent, proposed to him to make an instrument of the harpsichord kind, with such improvements as the workman could suggest. Pleased with his task, he thought it was agreed that the instrument was to bear the name of his master only, who proposed to take the credit of the work. Erard devoted himself assiduously to the production of the instrument. When it was completed, the musician who had purchased it was so much struck with its powers, that he returned to make inquiries from the harpsichord-maker on the subject of its construction. The man, taken by surprise, was unable to reply, and was at length compelled to admit that it was entirely the work of his young journeyman. From that time Erard's reputation began to spread. The Duchess de Villeroy, who devoted much of her fortune to the encouragement of the arts, having heard of the young artist, sent for him, and proposed to him to attempt the construction of a piano similar to those recently introduced into Saxony by Silberman; and it was in her house in Paris that the workman designed and completed his instrument—the first ever made in France, where, indeed, it was till then almost entirely unknown. Played at the concerts given by the Duchess, the instrument quickly gained in favour.

Sebastien Erard, in conjunction with his brother Jean Baptiste, set up a manufactory in Paris to meet the demand for the instrument; and here the ingenuity of the Strasbourg workman speedily introduced such important improvements that his instruments became

famous throughout Europe. It is said that an agent in Hamburg, in the year 1794, sold in that city more than two hundred of Erard's pianos. It is to the Erard establishment that the pianoforte players owe the upward bearing of the strings—a great improvement, now almost universally adopted.

THE ECCENTRICITIES OF THE HON. HENRY CAVENDISH.

THE passion, in certain minds, for scientific discovery, was perhaps never more curiously illustrated than in the account of the death of the Honourable Henry Cavendish, the natural philosopher. Cavendish, who died in 1810, in his seventy-ninth year, was a man of remarkably strong constitution. It is said that the illness which caused his death was the first as well as the last under which he suffered. Aware of the gravity of his situation, he determined to mark accurately the progress of his disease, and the gradual diminution of the vital powers. For this purpose, and in order that his attention might not be disturbed, he desired to be left alone. His servant returning to his master's bedroom sooner than he was ordered to do, his master, though then in a sinking state, desired him to leave him again. When the man came back a second time he found that his master had expired.

Cavendish's first scientific publication was a paper on Factitious Airs, which, for the first time, gave a dis-

tinct account of the properties of hydrogen and of carbonic acid gas. He subsequently devoted himself to natural philosophy generally; and published, in 1776, a curious account of his attempts to imitate the electrical eel by an apparatus constructed in imitation of the living fish in connection with a Leyden battery, by which he removed all doubts as to the identity of the benumbing power of the torpedo with common electricity. His discoveries concerning the composition of the atmosphere, the compound nature of water, and of the composition of nitric acid, and the density of the earth, place him in the highest rank of English philosophers. In order to solve the question of whether the atmosphere is constant in its composition, he made many hundred analyses of air.

This singular man, who was remarkable for his profound and original knowledge in almost every department of physical science, is described as living entirely apart from the world among his books and his scientific apparatus; never taking part in the affairs of active life, but passing his whole time in his favourite pursuit of scientific truth. His dress was always antiquated, his walk quick and ungraceful; he never appeared in the metropolis except lying back in his carriage, and it is remarked that he probably uttered fewer words in the course of his life than any man who ever lived to nearly fourscore. An admirer alluding to his large fortune, said that he was "the richest of all wise men, and probably the wisest of all rich men." He does not, however, appear to have been free from grave defects. His biographer, Dr. George Wilson, gives the following curious summary of his private character:—

“Morally it was a blank, and can only be described by a series of negations. He did not love, he did not hate, he did not hope, he did not fear, he did not worship as others do. He separated himself from his fellow men, and apparently from God. There was nothing earnest, enthusiastic, heroic, or chivalrous in his nature, and as little was there anything mean, grovelling, or ignoble. He was almost passionless. An intellectual head thinking, a pair of wonderfully acute eyes observing, and a pair of very skilful hands experimenting or recording, are all that I recognize in his memorials. His brain seems to have been but a calculating engine; his eyes inlets of vision, not fountains of tears; his hands instruments of manipulation, which never trembled with emotion, or were clasped together in adoration, thanksgiving, or despair; his heart only an anatomical organ necessary for the circulation of the blood. A sense of isolation from his brethren made him shrink from their society and avoid their presence; but he did so as one conscious of an infirmity, not boasting of an excellence. He was like a deaf mute, sitting apart from a circle whose looks and gestures show that they are uttering and listening to music and eloquence, in producing or welcoming which he can be no sharer. Wisely, therefore, he dwelt apart. He was one of the unthanked benefactors of his race, who was patiently teaching and serving mankind, whilst they were shrinking from his coldness or mocking his peculiarities.” He could not sing for them a sweet song, or create a ‘thing of beauty,’ which would be ‘a joy for ever,’ or touch their hearts, or fire their spirit, or deepen their reverence or their fervour. He was not a poet, a priest, or a prophet,

but only a cold, clear intelligence, laying down pure white light, which brightened everything on which it fell, but warmed nothing—a star of at least the second, if not of the first magnitude in the intellectual firmament.”

“All this appears to be fully borne out by the testimony of those who knew him. In spite of his ~~recuse~~ ~~in~~ ~~its~~ and dread of becoming famous, Cavendish’s reputation spread rapidly. About the year 1785, when his chief discoveries were made, his town residence was at the corner of Montague Place and Gower Street. Of this, and other houses of Cavendish, Dr. Wilson says, “Few visitors were admitted, but some found their way across the threshold and have reported that books and apparatus formed its chief furniture. For the former, however, Cavendish set apart a separate mansion in Dean Street, Soho. Here he had collected a large and carefully chosen library of works on science, which he threw open to all engaged in research, and to this house he went for his own books as one would go to a circulating library, signing a formal receipt for such of the volumes as he took with him. His favourite residence was a beautiful suburban villa at Clapham, which, as well as a street or row of houses in the neighbourhood, now bears his name. . . . A small portion only of the villa was set apart for personal comfort. The upper rooms constituted an astronomical observatory. What is now the drawing-room was the laboratory. In an adjoining room a forge was placed. The lawn was invaded by a wooden stage, from which access could be had to a large tree, to the top of which, in the course of his astronomical, meteorological, electrical, or other researches, he occasionally ascended.”

Cavendish lived comfortably, but made no display. His few guests were treated on all occasions to the same fare, and it was not very sumptuous. A Fellow of the Royal Society reports that if any one dined with Cavendish, "he invariably gave them a leg of mutton and nothing else." Another Fellow states that Cavendish "seldom had company at his house; but on one occasion three or four scientific men were to dine with him; and when his housekeeper came to ask what was to be got for dinner, he said, 'A leg of mutton.' To the servant's remonstrance that that would not be enough for five, he replied, 'Well then, get two!'"

Dr. Thomas Thomson gives the following account of Cavendish:—"He was shy and bashful to a degree bordering on disease. He could not bear to have any person introduced to him, or to be pointed out in any way as a remarkable man. One Sunday evening he was standing at Sir Joseph Banks' in a crowded room conversing with Mr. Hatchett, when Dr. Ingenhousz, who had a good deal of pomposity of manner, came up with an Austrian gentleman and introduced him formally to Mr. Cavendish. He mentioned the titles and qualifications of his friend at great length, and said that he had been peculiarly anxious to be introduced to a philosopher so profound and so universally known and celebrated as Mr. Cavendish. As soon as Dr. Ingenhousz had finished, the Austrian gentleman began, and assured Mr. Cavendish that his principal reason for coming to London was to see and converse with one of the greatest ornaments of the age, and one of the most illustrious philosophers that ever existed."

"To all these high-flown speeches Mr. Cavendish

uttered not a word, but stood with his eyes cast down, quite abashed and confounded. At last, spying an opening in the crowd, he darted through it with all the speed of which he was master, nor did he stop till he reached his carriage, which drove him directly home."

Sir Humphrey Davy, who could well appreciate the great discoveries of Cavendish, says, "He was a great man, with extraordinary singularities. His voice was squeaking, his manner nervous; he was afraid of strangers, and seemed when embarrassed even to articulate with difficulty; he wore the costume of our grandfathers. . . . He gave me once some bits of platinum for my experiments, and came to see my results on the decomposition of the alkalis, and seemed to take an interest in them, but he encouraged no intimacy with any one. . . . He was acute, sagacious, and profound, and, I think, the most accomplished British philosopher of his time." Another writer who knew him well—Mr. J. G. Children—says, "When I first became a member of the Royal Society Club, I recollect seeing Cavendish on one occasion talking very earnestly to Marsden, Davy, and Hatchett. I went up and joined the group. My eye caught that of Cavendish, and he instantly became silent; he did not say a word. The fact is, he saw in me a strange face, and of a strange face he had a perfect horror. I don't think I had been introduced to him, but I was so afterwards, and then he behaved to me very courteously." Lord Burlington informed Dr. Wilson, on the authority of Mr. Allnutt, an old inhabitant of Clapham, that Cavendish would never see a female servant, and if an unfortunate maid ever showed herself, she was immediately

dismissed." Lord Brougham says, that Cavendish ordered his dinner daily by a note, which he left at a certain hour on the hall table, where the housekeeper was to take it, for he held no communication with his female domestics. It is probable that these habits grew upon him; and that the anecdote of the leg of mutton, related by Dr. Wilson, referred to an earlier period of his life.

When Cavendish died, a discovery was made, which may well excite the imaginations of the romantic on the causes of his singular retirement and misanthropy. According to Sir J. Barrow, in one of his chests of drawers were discovered parts of richly-embroidered lady's dresses, and among other valuable articles, an old but magnificent stomacher, so beset with diamonds that when it came to be examined and valued, its worth was found to be nearly twenty thousand pounds.

Cavendish was the younger son of Lord Charles Cavendish, and grandson of the second Duke of Devonshire. Notwithstanding his lonely way of life, he is said to have shown himself in many respects a kindly and a liberal man. So simple, however, was his mode of living that his fortune greatly increased throughout his life; and when he died he was found to have bequeathed the enormous sum of twelve hundred thousand pounds, for division among his relatives and friends.

WILLIAM MURDOCH AND HIS INVENTIONS.

MR. MURDOCH, whose name is best known as one of the earliest of those who applied coal-gas to useful purposes, was the inventor of a great number of ingenious appliances. The son of an Ayrshire millwright, he settled at Birmingham, where his talents were discovered by Messrs. Boulton and Watt, who appointed him to undertake the charge of their new steam engines at Redruth, in Cornwall. Here Murdoch resided for nineteen years. A paper read by Mr. William Buckle, of Soho, before a meeting of the Institution of Mechanical Engineers, gives some interesting particulars of his sojourn in this part, where he gave so much satisfaction to the mining interest, that when his determination to return to Soho became known, they offered him £1000 a year to remain in Cornwall. During his residence there (says Mr. Buckle), Murdoch contrived and executed a model locomotive, which, as early as the year 1784, he was in the habit of showing to his friends in working order, and drawing a small waggon round a room in his house at Redruth. He used to tell a story, that, while making experiments with this engine, he one night determined to test its powers on a level road leading from his house to the church, which was situated about a mile distant from the town; this road was bounded on each side by high edges, and well suited for the purpose. Murdoch accordingly sallied out, and placing his engine on the ground, lit the fire, or rather

lamp, under the boiler, after a few minutes off started the locomotive with the inventor full chase after it. After continuing the pursuit for a short distance, he heard cries as if a person in great distress; the night was too dark to perceive objects afar off, but on going on, he found that the sounds proceeded from the clergyman of the parish who had set out for the town on business, and being met on this lonely road by the fiery monster, had taken it for the Evil One in person. This model locomotive was exhibited before a meeting of the Institution of Mechanical Engineers in 1850, sixty-six years after the date of its construction.

Returned to Scotland, Mr. Murdoch soon became one of the most conspicuous of the circle of scientific and ingenious men who were associated directly and indirectly with Watt and Boulton. His experiments with gas probably did more to strike the popular mind with the importance of that remarkable machine for the display of new inventions than all the marvels of the steam engine. Murdoch took out a patent for improvements in boring cylinders and in the manufacture of steam casings; this patent also included the double slide valve and a rotary engine. Amongst other inventions and discoveries of Murdoch's (says Mr. Buckle) are: a plan for boring stone pipes for water, and cutting columns out of solid blocks of stone (for which he took a patent in 1810); a pneumatic lift working by compressed air; and a cast iron cement, which he was led to discover by the accidental observation of some iron borings and sal-ammoniac, which had got mixed in his tool-chest and rusted a sword blade nearly through. He also made use of compressed air to ring the bells in his house, a

plan which so pleased Sir Walter Scott, to whom it had been described, that he had his house at Abbotsford fitted up in a similar manner.

Murdoch likewise discovered a substitute for isinglass, and when in London, for the purpose of explaining to the brewers the nature of his discovery, he occupied very handsome apartments. Being, however, at all times absorbed in whatever subject he had in hand, he little respected the splendour of his drawing-room, but proceeded with his experiments as if in the laboratory at Soho, quite unconscious of the mischief he was doing. This resulted in his abrupt dismissal from the apartments by the enraged landlady, who one morning, on calling in to receive orders, was horrified at seeing all her magnificent paper hanging, covered with wet fish skins, hung up to dry, and actually caught him in the act of pinning up a cod's skin to undergo the same process.

Mr. Murdoch met with an unfortunate accident in the year 1815, from the effects of which he never entirely recovered. While fitting up an apparatus of his own invention for heating the water of the baths at Leamington, a heavy plate of cast iron fell upon his leg above the ankle, nearly severing it in two. He lived, however, till 1839, when he died at Handsworth in his eighty-sixth year. His remains were deposited in Handsworth church, near to those of his old friends and fellow-workers, James Watt, and Matthew Boulton.

